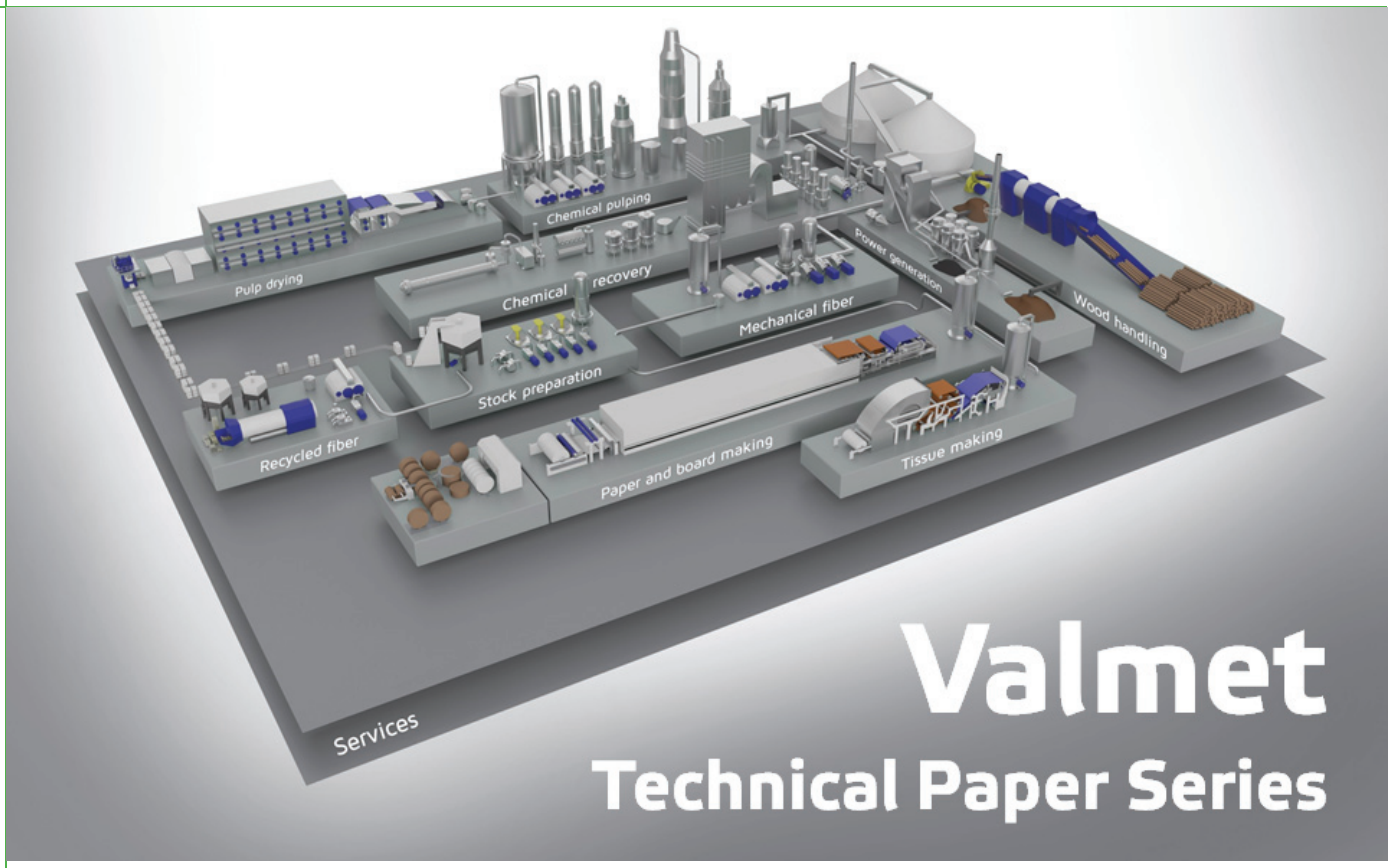


Press Fabrics

Executive Summary

The most important web transfer component on a paper or a board machine is the fabric. This white paper will discuss two related areas: press felts and shoe press belts.

Within the press felt area, we will first look at two Field Reports; general press fabric monitoring best practices and the issue of streaking on one machine. The discussion continues with felt stretching focusing on Valmet's fully automatic FeltStretch P. Nonwoven and hybrid felts are presented, including TransMaster Open, AquaMaster and EcoMaster and how they can reduce costs over their lifetimes.

The shoe press belt section of the paper talks about the BlackBelt Family. The four unique surface designs; smooth, grooved, semi-grooved, and discontinuous grooves, are examined as well as the concept of parallel and spiral grooves. Additionally, the advantages of the BlackBelt HD shoe press as well as the benefits of the newest BlackBelt E are reviewed.

Press felts

Please note that the following Field Report content is based on field service engineer experience during hundreds of in-mill service calls and may not conform to everyone's point of view.

Field Report #1 - Press fabric monitoring best practices

Having a good press felt monitoring and conditioning system is paramount to avoid paper machine runnability and quality problems. This article will discuss some best practices around press felt monitoring and cleaning.

Figure 1. Press felts require good monitoring and conditioning systems.

To begin, there is no single approach to keep press felts performing well. Machine press design, grade, furnish, speed, and wet end additives differ by machine, so each requires a tailored program to keep their press section operation optimized. Before discussing what the cleaning schedule should be, you must identify what type of contaminants are in the press felts that affects water carrying capacity of the felts. This can be done by performing a used felt analysis.

From the test results, a chemical cleaning program can be developed. Chemical programs may include caustic, acid, or detergent type chemicals. These washes are carried out either by batch on the fly, batch during sheet breaks, continuously, or a combination of these. Each machine needs to be optimized by using one or more of these cleaning methods. Many mills will perform a scheduled batch on the fly felt cleaning, usually every 1-2 days. Others will opt for only doing batch washes during sheet break situations or when sheet defects get high or machine runnability too low. In either case, a good wash-up of the press section needs to be done periodically to eliminate debris that collects on the press section felt rolls, doctors, uhle boxes, saveall pans, and machine frames.

For sheet side felt rolls with doctor blades on them, remember to wash behind and under the doctor blades, especially if the blades are pulled out for replacement to eliminate deposits that could dislodge and get transferred directly to wet felt and eventually to the sheet. Deposits on the top of the doctor blades don't usually cause sheet defects - it's what is under the blade that will cause the most harm as uhle boxes don't do a very good job at removing fiber clumps from the press felt surface.

Used felt analyses are important, but there are other tests that can be performed while the felt is running that can help explain machine runnability, drying demand, moisture profiles, sheet defects, etc. These include press felt moisture profile scans and water permeability scans. Moisture scans can identify wide and narrow type of felt moisture profile irregularities and give an idea of press nip pressure profiles on young wet felts, before the felt becomes too compacted. Moisture scans are normally taken before and after the uhle boxes when possible. This provides information on the amount of water that the felt is carrying into and out of the press nip and the efficiency of the uhle box at removing water from the felt.

In the early life of a wet felt, these moisture/permeability scans tend to be higher as most wet felts start out as being felt, or uhle box, dewatering – a condition where most of the water in the press nip is carried out of the nip with the felt. As the felt ages and is compacted and filled, its water carrying capacity trends go

down and more water is removed at the press nip. By trending these measurements, along with uhle box vacuums, one can determine how a felt is running compared to historical wet felts. These trends also give insight into how effective the felt conditioning program is. For example, the uhle box vacuums will increase as the felt fills with fiber, fines, and wet end additives. After a batch cleaning, vacuums will drop and the press felt will be able to carry more water out of the nip once again. At the end of the press felt's life, even batch washes will only have limited ability to open the felt structure back up.

One other comment on nip dewatering, as more water is removed at the nip, there is more water spray and thus more fiber buildup on the savealls and machine framework. These areas will tend to build up deposits quicker and cause issues with sheet defects and machine breaks. They should periodically be cleaned during wet end sheet breaks.

If the moisture/permeability scans indicate irregular or streaky profiles, the source of the streaks needs to be determined. Often the source of the problem can be traced back to plugged or partially plugged shower nozzles – either low pressure fan type conditioning and lubrication nozzles or high pressure needle shower nozzles. Low pressure shower nozzles that are used for chemical application need to cover 100% of the felt, overlapping if possible, and oscillated in a perfect world. Partially plugged high pressure needle showers can do more harm than plugged nozzles if the spray pattern breaks up and becomes turbulent before contacting the felt. This condition increases the felt's wear rate.

For these needle showers, mills have been having good luck using ruby tipped nozzles and a clean filtered source of water for long nozzle service life. High pressure showers are normally set in the 150-200 psi range depending on machine. In summary, all shower nozzles and oscillating systems need to be functioning properly in order to maintain flat moisture and permeability profiles and extend fabric life.

Interpreting the press felt moisture scans and water permeability requires good understanding of the press section and wet felt design. Moisture scans and water perms change over the life of the wet felt. Comparisons between wet felts should be made at similar ages. Early in their life, moisture content after the press nip will be higher as there is more void volume in the felt. At this stage, the felts will also accept more water as seen on the permeability scans. Looking at the moisture and permeability scan profiles during this stage of dewatering can be quite useful in understanding what the roll nip load profiles look like.

On most uhle box dewatering felts, the felt moisture will tend to be higher where there is more nip loading as more water is forced out of the sheet and into the wet felt (i.e. on an under-crowned nip, felt moisture will be higher on the ends than in the center of new wet felts). As the felt compacts over the course of a week or two, the moisture in the felt after the nip decreases and more water is removed at the nip. On applications that start out nip dewatering, the opposite is seen – lower felt moisture where the nip load is higher. In either case, as the felts age, they compact and become more nip dewatering. Determining relationships between moisture profiles and nip load conditions becomes more difficult as the felt ages and deficiencies in felt cleaning systems affect felt moisture/perm profiles.

Another wet felt monitoring tool is an infrared thermal camera. Some fabric supplier representatives have hand held thermal cameras that can be used to identify thermal banding in the wet felts and in the sheet coming over the center roll. Hot edges on pickup felts with steamboxes on the suction roll will be seen if the suction roll deckle seals are set out too far. Any hot streak should not be more than 1/2" wide and less

than 5-10 °F higher than the rest of the felt. If more than this, the felt strands and batting will oxidize and can cause edge pickup issues later in the felt life.

In summary, monitoring wet felt and press performance is a critical means to explain machine operating performance. Valmet has knowledgeable press felt service representatives that can help your mill understand how your press felts are performing. They also gather a lot of relevant machine information and conduct thorough inspections of the press section equipment as part of their service to the mill. From their observations and experience, they can make recommendations and suggestions for future wet felt design changes and equipment/process upgrades.

Field Report #2 - Press fabric streaking

A paper machine with a tri-nip press was having sheet quality problems with scuff marking after a normal machine outage. These scuff marks could be seen at the reel as the jumbo roll was building and especially after coating the base paper. The scuffs were located across the entire machine in 1-10" discrete bands. One of the machine operators noticed that there were white bands on the center roll that appeared to be similar in spacing. This was not normal. A CD paper sample was marked with the scuff marking zones and compared to the center roll buildups and found to be a close match. With the machine down, the white buildup was found to be a filler material.

Two contributing factors combined to create this quality problem. First, the filler streaking on the center roll would not be a problem if the center roll doctor was working properly. It was found that the setup of the doctor beam was wrong. A larger DST loading tube was installed on the load side of the DST on the machine outage. The unload side tube size was not changed. In order to properly set up a DST doctor blade, you first equalize the pressure on both tubes, and then set up the blade beam angle to the roll. Since the load size of the DST was larger, the blade was in a pre-loaded position when the beam angle setup was done. When loaded against the center roll with this larger load tube, there was visibly more bend to the blade than normal. Because of the sharp bend to the doctor blade, the blade was not riding on the sharp tip and not doing an adequate job of cleaning the center roll. The larger load tube had to be replaced with the standard load tube and then the doctor beam had to be reset to the proper angle.

Figure 2. Poor center roll doctoring combined with this severely streaky bottom press wet felt to create sheet quality problems.

A second contributing factor for the filler buildup on the center roll in the first place was a severely streaky bottom press wet felt (**Figure 2**). The scuff pattern and the center roll filler bands matched the streaks on the bottom felt perfectly as well. It was found that the light colored bands on the inside of the felt corresponded with dark bands on the outside of the felt and vice versus. The chemical cleaning system on this felt run was located on the inside of the felt run right before the uhle box. In order to clean the sheet side of the felt, the uhle box has to suck the chemical through the felt. Where the felt appeared to be "clean" (white) on the inside, the felt was actually plugged (no purple dyed water flowing through felt in the 1st press nip). Where the felt was purple on the inside the felt was open (free

purple water flow through felt in the press nip). The center roll buildups lined up with the plugged portions of the bottom wet felt.

Apparently, where this bottom felt was plugged, more loosely bonded filler stayed on the sheet surface before contacting the center roll in the second nip. After the bottom wet felt was changed and doctor blade reset, no more scuff marks were reported. This example shows the importance of properly setting up center roll doctor blades (~27°) and having a good wet felt cleaning program. All low pressure fanning showers need to be working and overlapping. Visible streakiness on either side of the felts should not be seen.

FeltStretch P – Fully automatic felt stretching

Fabrics are the most important web transfer component on a paper or a board machine. Web run problems may lead to speed decreases and ultimately to production losses. Valmet's stretchers ensure constant fabric tension and thus enable smooth web runnability. Better fabric tension control maximizes fabric service life.

In an innovative press rebuild project (Press configuration shown in **Figure 3**), a new automatic FeltStretch P felt stretcher (**Figure 4**) was supplied to keep the 1st press and lump breaker tandem felt tension steady during the machine run. If for some reason the lump breaker roll on that machine is raised from its operating position, the stretcher compensates for the slack in tension in order not to lose the felt. (When a press section loads and unloads there is little difference in the felt tension/length, but when a lump breaker loads/unloads there is a significant change in felt tension/length. The lump breaker is typically only raised during a break for cleanup if needed.)

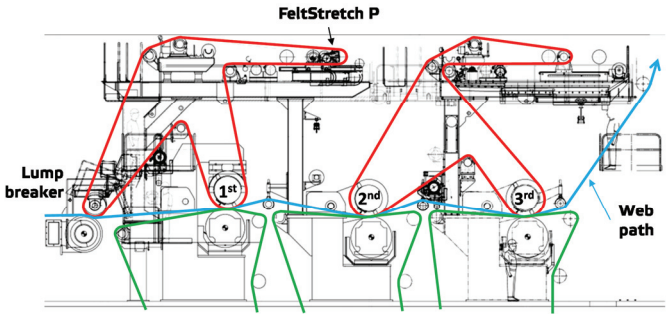


Figure 3. The layout of the double-felted innovative press rebuild project required a good felt stretcher.

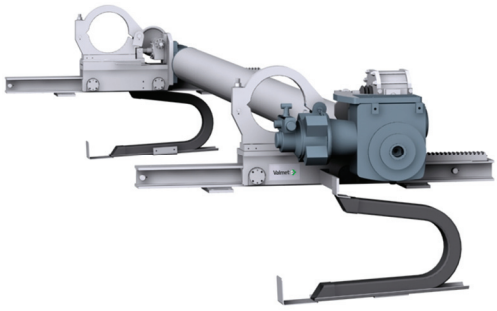


Figure 4. The FeltStretch P pneumatic felt stretcher is designed for fabric control with minimum maintenance.

The stretcher was equipped with a manual felt squaring hand wheel. The delivery included new posts and pads to adapt the stretcher to the existing top felt run. In the press section, automatic felt seam straightening is an option with Valmet's hydraulic and pneumatic felt stretchers. With seam straightening the shaping and wear of the felts can be controlled and the useful life of felts can be extended.

All Valmet stretchers come with gear transmissions. No chains are used (**Figure 5**, next page). This results in a non-vibrating design with a minimum number of wearing parts and reduced maintenance needs. The unique and simple design features minimal clearances providing solid, vibration-free operation and accurate stretching.

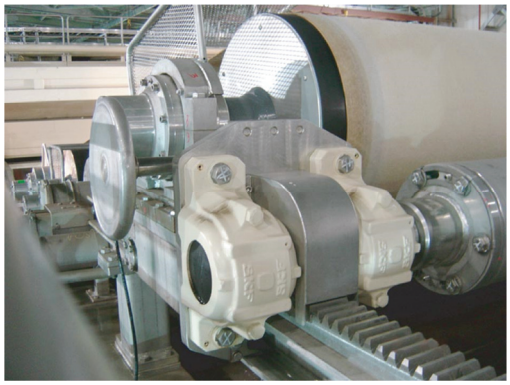


Figure 5. Valmet stretchers require minimal clearances, using gear transmissions rather than chains.

The fabric is stretched by means of a movable cross-machine roll which is situated such that when the roll moves in the machine direction, the length of the fabric loop changes accordingly. The roll is mounted by its bearing to the stretcher carriages, and as the carriages move, they also move the roll, changing the length of the fabric loop and stretching the fabric.

With the FeltStretch P, the stretching force is created by means of a pneumatic cylinder in which the suitable stretching pressure is applied. The air motor in the stretcher is not used for changing the tension achieved with the cylinder. The motor is only used for returning the cylinder into an operating range by transferring the carriages and hence also the stretching shaft. A constant pressure of 60 to 75 PSI is applied at the air motor. The cylinder pressure is typically set at 50% of the pressure corresponding to the desired tension.

If pressure is lost during disturbances such as breaking the air motor pressure hose or depressurization of the supply piping, the stretcher maintains the tension needed. This gives greater operational safety and protects the fabrics from damage. The pneumatic model features flexible stretching based on the elastic properties of the bellows. Should the clothing stretch due to shrinkage or slacken due to yielding, the position of the cross-shaft will automatically change while the tension will remain as set. This also protects fabrics during disturbances.

Save energy and improve total lifetime performance with nonwoven and hybrid TMO (TransMaster Open) felts

Valmet has further developed its nonwoven and hybrid felts to better meet today's customer demands for energy savings and better machine runnability. Nonwoven and hybrid felts are well-known for their fast start-up and high nip dewatering (**Figure 6**). Their sophisticated TMO versions also ensure excellent runnability.

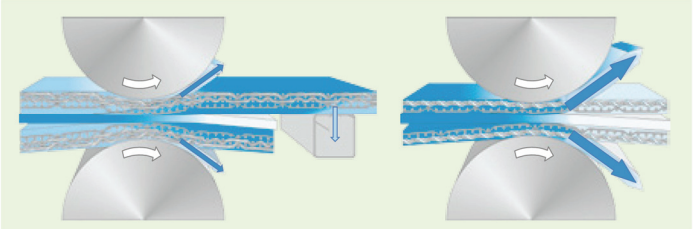


Figure 6. The water removal of conventional laminated felts (left) compared with nonwoven and hybrid felts (right)

Felts play a major role with regard to efficiency and cost savings. As the process is complex it is important to analyze the whole process, not only one part of it. When purchasing a felt going for a cheaper option might, in the worst case, result in additional costs during the felt running time. It is better to analyze a felt's real effect on machine efficiency by looking at the felt costs per produced paper tonnes and the savings (e.g. energy reduction and saved production time) that can be achieved with certain felts.

Energy savings through the right press felt choices

Big savings can be achieved by reducing energy costs in the paper machine. Electricity usage in the press section is huge and adds up to hundreds of thousands of euros every year. About 20-30% of electricity

usage is related to Uhle boxes. Their friction increases the energy consumption of drives, and the Uhle box vacuum increases vacuum energy consumption.

Energy can be saved by using nonwoven and hybrid felts, which maximize nip dewatering meaning that minimized or no vacuums are required in the Uhle boxes.

Standard nonwoven and hybrid felts: AquaMaster and EcoMaster

AquaMaster's immediately saturating structure allows a very fast start-up and maximal nip dewatering. As all the water is removed in the nip, Uhle boxes do not increase sheet dryness. Rewetting is minimized with a special layer.

Nip and Uhle box dewatering
- Felt water content higher after nip
- Open and medium heavy weight felts
- Longer felt start-up time
- Typical felts: conventional laminated

Nip dewatering
- Felt water content equal or lower after nip
- Dense, thin and light weight felts
- Fast felt start-up
- Typical felts: nonwoven, hybrid AquaMaster / EcoMaster

Figure 7. The water removal of conventional laminated felts (left) compared with nonwoven and hybrid felts (right)

EcoMaster is the combination of a woven and nonwoven structure. Its nip dewatering properties are excellent, but Uhle boxes can be used if necessary. Additional benefits compared with nonwoven felts include its smooth surface, insulation against marking, dimensional stability and less plugging.

Many machines already use AquaMaster and EcoMaster felts and run with maximized nip dewatering, which saves a lot of energy with closed vacuum pumps or blowers.

New: high-end TMO nonwoven and hybrid designs

Nonwoven / Hybrid felts
= Energy savings

Nonwoven / Hybrid + TMO
= Energy savings and improved lifetime performance

Figure 8. Benefits of Hybrid vs. Hybrid + TMO felts

Saving energy is not enough when the aim is to achieve efficient running. It is also important to improve runnability and total lifetime in other ways. In addition to good and even runnability, a minimal number of breaks, a high dry content and a maximal running speed are also important. A fast start-up and unchanged felt behavior are very important for the machine to run continuously at full speed. Minimal felt wear and a non-plugging structure ensure good life potential. A longer lifetime means fewer felt change shutdowns and savings in purchasing costs (**Figure 9**).

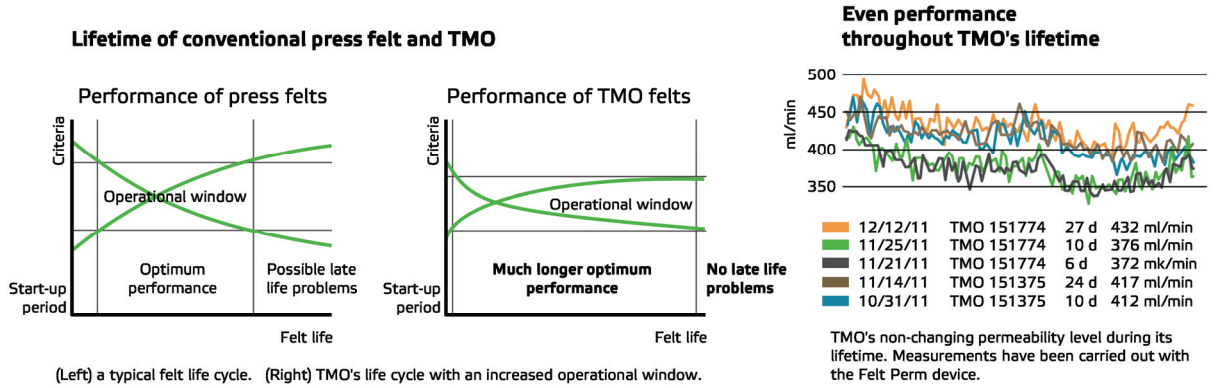
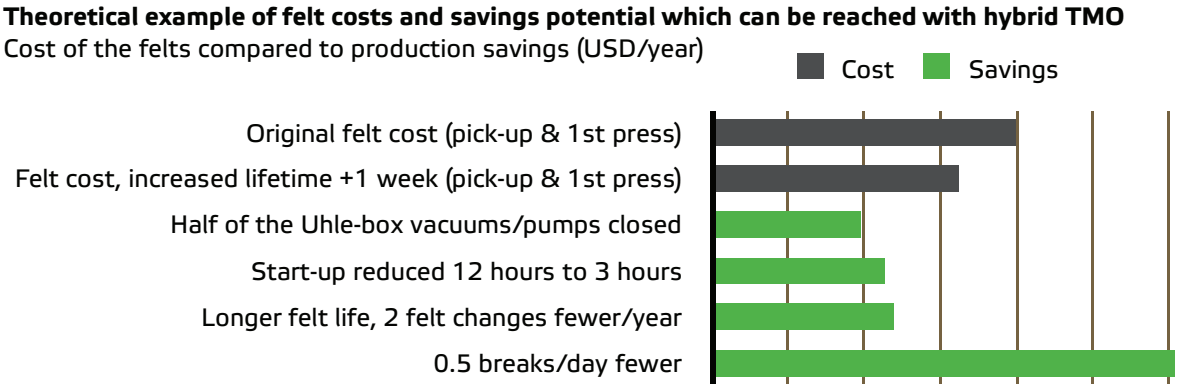


Figure 9. The water removal of conventional laminated felts (left) compared with nonwoven and hybrid felts (right)

The sophisticated hybrid base TMO (TransMaster Open) felt has proven to be superior in this respect. It is a special felt for very demanding machines, such as high-speed printing paper machines.

Impregnated resin treatment ensures TMO's even performance throughout its lifetime. This treatment makes the felt structure dense and non-compacting, and perfect for a fast start-up and immediate nip dewatering. The structure remains unchanged throughout the lifetime with no late life related problems such as edge flipping or plugging. Improved mechanical resistance gives the TMO felt long life potential and makes it durable, also under high nip pressures, even if the base fabric is nonwoven or hybrid.



Theoretical example: newsprint machine, SymPress II + 4th press, speed 1700 m/min, paper 45 g/m^2, paper on reel 8.7 m. Felt size: pick-up 380 kg, 1st press 280 kg. Felt lifetime 5 weeks (= 11 felts/position/year).

Figure 10. Hybrid TMO felt cost and production savings

The savings gained through making the right felt choices are significant. **Figure 10** shows an example of felt costs compared with savings achieved with the right felt choices.

The hybrid TMO felts are increasingly used in many of the world's fastest newsprint and fine paper machines, especially in pick-up and 1st press positions, to ensure trouble-free running.

Riaupaper PM 1 and PM 2 run full speed ahead with Valmet fabrics and machinery

Valmet's fabrics have had a significant effect on the dewatering efficiency and runnability of the Valmet-supplied Riaupaper PM 1 and PM 2 in Indonesia. Both machines produce premium-quality office paper.

The press felts have been running successfully on both machines since their start-up in 1998 and 2006, respectively. Riaupaper selected a Valmet felt package for its PM 2 based on the good experience and results of the cooperation gained on PM 1 and the quality of the fabrics. A good fabric reference from another OptiConcept machine in Asia also played an important role in the decision making.

The press felts perform outstandingly and have guaranteed premium paper quality throughout the effective felt lifetime. Co-operation programs and on-site support have produced results in production by ensuring that the right felts are running.

The 9,350 mm wire width Valmet-supplied machines are among the fastest uncoated woodfree paper machines in the world and they are used as a benchmark by other office paper suppliers. In August 2008, PM 2 reached a new 24-hour record of 1,667 m/min, exceeding the design speed of 1,600 m/min by a

considerable margin. It is one of the top three fastest uncoated woodfree paper machines in the world. PM 1 recently set a new speed record of 1,510 m/min. It is operating continuously above 1,500 m/min, which is equally clearly above the original design speed of 1,340 m/min.

Riaupaper PM 1 SymPress B press section

- Pick-up felt, 1st press and 2nd press: Ecostar

Riaupaper PM 2 OptiPress press section

- Pick-up felt: EcoAqua
- 1st press bottom felt: Aquastar
- 2nd press top felt: Ecostar

Save costs by optimizing water removal

Water removal at the forming or press section is significantly cheaper than at the dryer section. Since removing one liter of water from the sheet at the dryer section costs five times more than at the press section, it pays to optimize dewatering at an early stage.

A one percentage point increase in dry solids content after the press section decreases the need for steam at the dryer section by up to five percent. Therefore, it offers a reasonable savings potential or extra capacity in drying-limited machines.

Traditionally, water removal from the web in the press section has been carried out with felts, which mainly remove water with the help of suction boxes (so-called Uhle box dewatering). More than one-fifth of the total energy consumption of the press section is used to produce vacuum; the remaining four-fifths are used by sectional drives. More effective dewatering methods increase the need for vacuum and energy exponentially, as well as shortening the lifetime of the felts, which get worn by friction due to rubbing against the suction box covers.

Roll-based water removal requires suitable press felts

In a modern press section, water is removed from the sheet with a nip load through felts onto roll surfaces, from where it is transferred to save-alls with the help of a foil doctor. Vacuum is mainly needed for suction rolls and suction press rolls. Some suction boxes can even be shut down, which significantly saves energy. Additional savings can be gained through extended felt lifetimes and reduced demand for electric drive power (**Figure 11**).

One prerequisite for optimal press roll dewatering is that the press felts are suitable for the position in question. Valmet's AquaMaster felt (**Figure 12**, next page), made of non-woven base material, and Valmet's hybrid felt, made of a combination of non-woven and woven base material, generate higher hydraulic pressures and allow the water to flow easily through the felt onto the roll surface. Correspondingly, there must be sufficient void volume for the water on the roll surface.

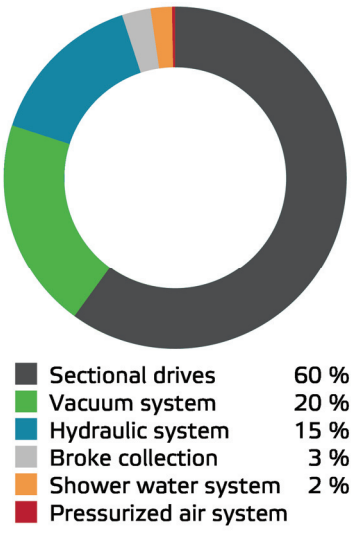


Figure 11. Typical distribution of electric energy consumption by a modern press section.

The structure of the new Valmet felt types promotes efficient nip dewatering, where water flows directly through the felt without any machine-direction movement. The surface of the felt is smooth against the sheet, which ensures good end product quality and the absence of marking, even with delicate grades. The light, yet tight, structure of the base material shortens the breaking-in time of the felts and thus maximizes the line's production capacity.

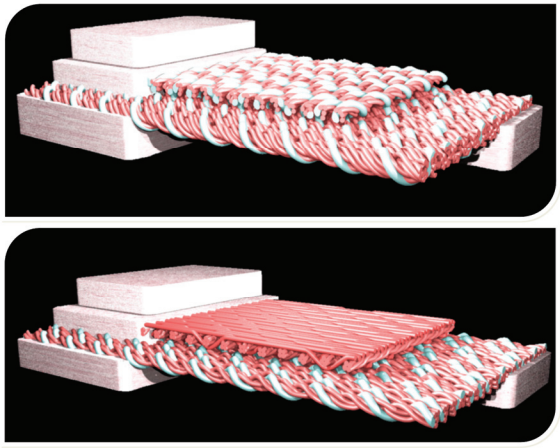


Figure 12. Both the non-woven AquaMaster (top) felt and the hybrid EcoMaster (bottom) felt, which is a combination of woven and non-woven base materials, are suitable for nip dewatering.

Prerequisites for process optimization and maximal dry solids content

- The press felts need to be suitable for the process in question. For example, Valmet's press felts allow water to pass through rapidly, and also prevent marking and rewetting.
- The press roll surfaces must be equipped with correctly-sized grooving to ensure enough effective void volume. For example, Valmet's PressFox polyurethane cover can handle closely-spaced grooving without breaking.
- Water is removed from the roll surface with effective foil doctors, such as Valmet's ValDual doctors.
- All savealls have been designed and placed correctly to prevent rewetting.
- The roll covers must be flexible enough to create a uniform nip load.
- The suction power of the suction boxes has been adjusted so that the felts are not overdried.

Correctly-sized grooving adds to void volume

Water removal in the nip calls for effective void volume on the roll surfaces. Traditional and blind drilling, which is still used, does not provide much void volume, regardless of its seemingly large volume. Correctly sized cover grooving is a much more effective way to increase void volume.

Table 1 (next page) shows some void volumes created by different groove sizes. Blind drilling increases void volume only slightly.

Adequate groove density and width are important in making sure that the roll surface is able to receive all of the water removed at a nip, even when worn down. Too narrow grooves (e.g. 0.5 mm) easily close up under the nip load and can also get clogged by dirt. Valmet recommends closely spaced wide grooves without the risk of shadow marking.

Correctly selected Valmet press felts will keep even the most delicate paper grade free of marking under heavy nip loads. Valmet's TransMaster Open and SeamMaster Open felts feature a special polymer treatment that evens out the nip load and water removal at a micro level, thus preventing marking.

Appropriate totality allows maximal dry solids content

Trial runs and practical experience have shown that raising the web temperature significantly increases the sheet's dry solids content as the water viscosity decreases and nip water removal increases. A steambox

adds dry solids content after the press by up to two percentage points. Replacing suction boxes with optimal water removal through the roll surfaces saves energy and makes mechanical water removal more efficient.

The easiest way to gain savings in energy consumption and wear parts costs through press optimization is to assign comprehensive responsibility for the press section to one supplier. Valmet can deliver extensive know-how and a broad product range for efficient press section water removal.

Grooving					Grooving + Blind Drilled	
Width (mm)	Land (mm)	Depth (mm)	Open area (%)	Void volume (liter/m^2)	Void volume (liter/m^2)	
0.5	2	1.0	20.0	0.20	0.22	
0.5	2	2.0	20.0	0.40	0.44	
0.5	2	3.0	20.0	0.60	0.65	
0.6	2.3	1.0	20.7	0.21	0.22	
0.6	2.3	2.0	20.7	0.41	0.45	
0.6	2.3	2.5	20.7	0.52	0.56	
0.6	2.3	3.0	20.7	0.62	0.67	
0.6	2.5	1.0	19.4	0.19	0.21	
0.6	2.5	2.0	19.4	0.39	0.41	
0.6	2.5	2.5	19.4	0.48	0.51	
0.6	2.5	3.0	19.4	0.58	0.62	
0.6	**1.65**	**5.0**	**26.7**	**1.33**	**N/A**	**G-band**
0.8	2.5	1.0	24.2	0.24	0.26	
0.8	2.5	2.0	24.2	0.48	0.51	
0.8	**2.5**	**2.8**	**24.2**	**0.68**	**0.72**	**Valmet Poly**
0.8	2.5	3.0	24.2	0.73	0.77	

Table 1. Effective void volumes with different groove sizes. Blind drilling increases effective volume only slightly, making groove width and groove density much more important. G-band covers provide the largest void volume.

Shoe press belt

Excellent BlackBelt experiences: "It runs like a roll!"

Those very words exclaimed by a papermaker are probably the highest compliment a shoe press belt can earn (**Figure 13**).

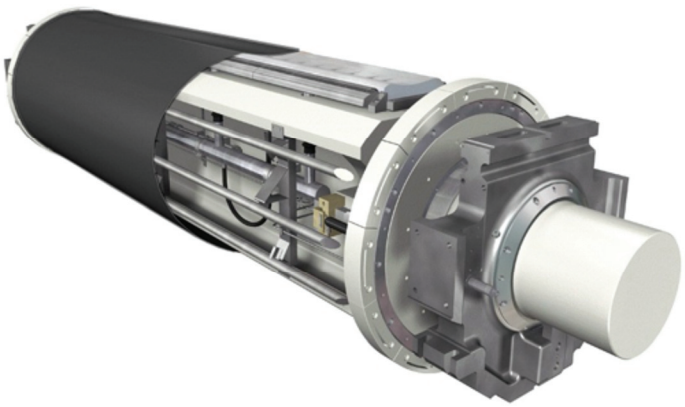


Figure 13. BlackBelt shoe press belt

BlackBelt shoe press belt

"Papermakers want a shoe press belt to perform well until the next planned shutdown – and BlackBelt has done exactly that. It survives for a long time in harsh conditions and keeps water removal at a high level," says Satu Hagfors, Product Group Manager, Belts, PMC business unit at Valmet.

Since its introduction in 2008, this new-generation shoe press belt has proven its reliability in many paper, board and pulp machines. It has performed extremely well even in the world's fastest-running newsprint machines. So far, over 1200 BlackBelts have been ordered, several hundred have been delivered, and invaluable user experience has been gained.

Unique in many respects

BlackBelt is a direct descendant of Tambelt 3G, the well-known blue shoe press belt, from which it has inherited many excellent properties, including good dimensional and running stability. It also features Tambelt's patented V-groove, which has proven its dewatering properties in many paper and board machines all over the world. This groove geometry retains its void volume even under the highest loads.

BlackBelt is available in smooth, grooved, semi-grooved and discontinuously grooved designs (**Figure 14**), and with a double or triple layer structure depending on the application. Smooth or plain belt is for shoe presses with no nip dewatering. The press felts carry the water to the uhle boxes. Grooved belt is for fast paper machines. Semi-grooved belt is for high water content to add to the void volume of the press felt. The water is sucked out of the grooves by the felt. SG-belt with shallow and wide grooves is specially developed for improving dryness in pulp machines and for fluting. Discontinuous grooves prevent water flowing backwards in the nip.

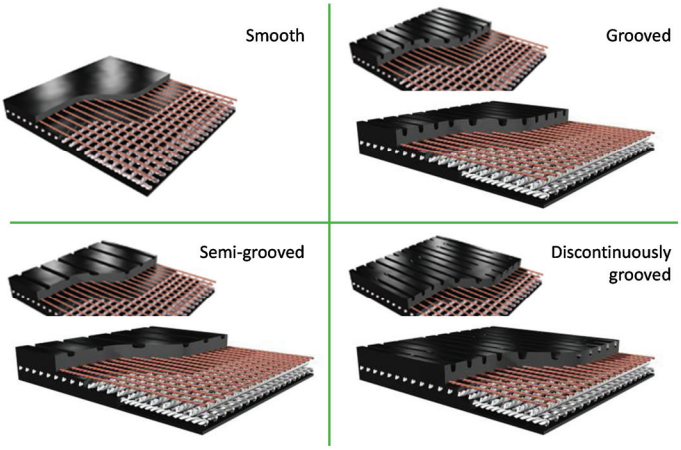


Figure 14. BlackBelt surface options: smooth (top left), grooved (top right), semi-grooved SG (bottom left) and discontinuously grooved DG (bottom right)

There are, however, three major differences compared to Tambelt. One is the raw material. The new polyurethane has excellent dynamic properties and retains its modulus over a wide temperature range. Therefore, its properties remain stable throughout its whole life. The wear is minimal, even in harsh conditions.

The new polyurethane has excellent dynamic properties and retains its modulus over a wide temperature range. Therefore, its properties remain stable throughout its whole life. The wear is minimal, even in harsh conditions.

The second difference is inner surface quality. The BlackBelt shoe press belts are manufactured by centrifugal casting. The method produces a smooth, shiny inner surface, which, combined with a friction-reducing treatment, results in as low friction as possible between the belt and the shoe press. This, in turn,

keeps the inner surface in good condition and reduces energy consumption. The largest diameter of BlackBelt is 1,800 mm and the maximum width is 14 m.

The casting method produces a smooth, shiny inner surface, which combined with a friction-reducing treatment, results in as low friction as possible between the belt and the shoe. This, in turn, keeps the inner surface in good condition and reduces energy consumption. The solution has been developed in cooperation with Valmet's shoe press specialists.

The optimized 3G structure is the third difference that makes BlackBelt unique. It has reinforcement yarns in three layers, which increase both dimensional stability and mechanical strength.

In operation, this unique structure means reliability and a long life. "Thanks to this structure, the belt runs in a stable way without wobbling and doesn't come into contact with the machine frame. Doctoring is easier too," Hagfors remarks.

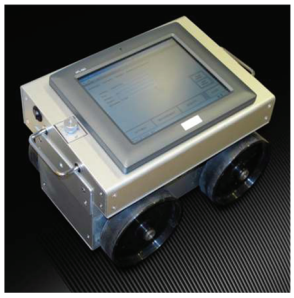


Figure 15. Valmet belt scanner

More accurate void volume change measurement

During shutdowns, Valmet uses a new belt scanner (**Figure 15**) to measure open area and void volume changes in the belt (groove dimensions such as groove depth, groove width and land width). The measuring results (**Figure 16**) enable papermakers to plan the timing of the belt change better.

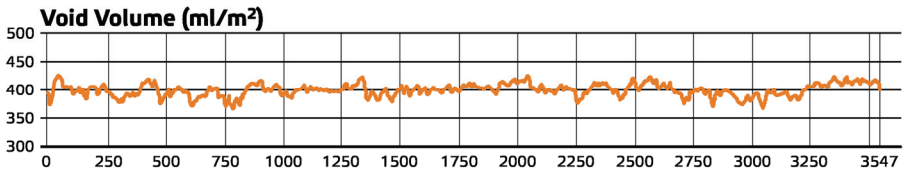


Figure 16. Example of Valmet belt scanner graph

BlackBelt also available with spiral grooves

The grooved BlackBelts have since the very beginning had parallel grooves, i.e. every single groove makes a full round. The idea behind this solution was to eliminate any forces that would move the belt sideways.

The polymer used in Blackbelt has proven to be very wear resistant. In some positions, the result has been exceptional wear in the belt doctor blade. The belt has not worn, but there has been grooved wear in the doctor blade similar to the grooves of the belt. The belt doctors do not oscillate, so the position of the doctor on the belt is always the same. As the belt is moved sideways (indexed), the doctor blade stays in the original position, posing a risk for both the belt and the doctor blade.

When the grooving is made into a single long spiral along the belt, this wearing will not occur. **Figure 17** shows the difference between these groove alternatives. In pilot machine runs or on production-scale trial runs, the spiral groove has not had any effect on the guiding of the belt or the felt in the nip. In theory, the spiral groove would also yield a better pressure profile through the felt.

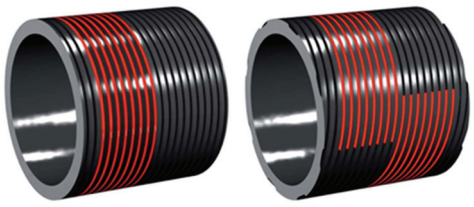


Figure 17. Parallel grooves (left) and spiral grooves (right)

There is no other difference between the two groove alternatives. Their groove shape is the same patented V shape typical of Valmet's (formerly Tamfelt) belts. The standard void volumes between 130 ml/m^2 and 510 ml/m^2 are available as before. (See **Table 2** showing the most common groove/land alternatives with the resulting void volumes.)

The almost non-existent polymer wearing, excellent pressure resistance and the well-working groove shape have, in many positions, shown the best water removal in the market. For example, on a double shoe machine with a BlackBelt, the draw between the press and dryer sections went down from 2.30% to 2.15%. After the belt was changed to another type, the values went back to the original level. A correctly applied BlackBelt saves costs!

Groove width (mm)	Groove depth (mm)	Land width (mm)	Open area (%)	Void volume (ml/m^2)
0.7	1.1-1.3	1.8	28	280-320
0.9	1.1-1.3	1.8	33	340-400
0.9	1.1-1.3	2.0	31	320-370
0.9	1.1-1.3	2.2	29	300-350
1.1	1.1-1.3	1.8	38	390-460
1.1	1.1-1.3	2.0	35	370-430
1.3	1.1-1.3	1.8	42	440-510
1.3	1.1-1.3	2.0	39	410-480
1.3	1.1-1.3	2.2	37	390-450

Table 2. Standard grooves

	Groove width (mm)	Groove depth (mm)	Land width (mm)	Open area (%)	Void volume (ml/m^2)
SG	1.6	0.5	4.3	27	140
DG	0.9	1.1-1.3	1.8	33	340-400
DG	1.3	1.1-1.3	1.8	42	400-460

Table 3. Special grooves(SG = semi-grooved, DG = discontinuous groove

The new BlackBelt HD shoe press belt makes marking disappear

A shoe press indisputably provides advantages compared with a roll press. Although the peak pressure in a shoe press is lower than that in a roll press, the dwell time is significantly longer due to the nip length. This makes it possible to remove more water from the web with a shoe press nip than with a roll press nip. A higher dry content after the press reduces steam consumption in the dryer section and saves energy. Quality properties are also often better with a shoe press, and the correlation between the bulk and the dry content is also more advantageous.

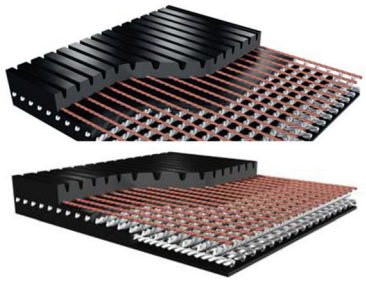


Figure 18. Structure of new BlackBelt HD shoe press belt (cutaway view)

In the early days, shoe presses were run with smooth belts, and all the water removed in the nip had to be absorbed by the press felt. In the quest for higher dry contents, grooves were introduced in belts. A typical void volume in the first grooved belts was under 300 ml/m^2, while the open area was under 25%. When the amount of water removed in the nip increased, there was a gradual move towards higher void volumes.

Today, belts typically feature void volumes of 380–520 ml/m^2, with an open area of 30-42%. The open area forms an uneven press profile on the felt because it is only the lands that transfer load on the felt. This profile unevenness together with a long dwell time may, depending on the grade, cause marking. This issue can be solved by using a stiff, heavy felt that evens out the load profile in the nip. However, this has a negative impact on the nip's water removal.

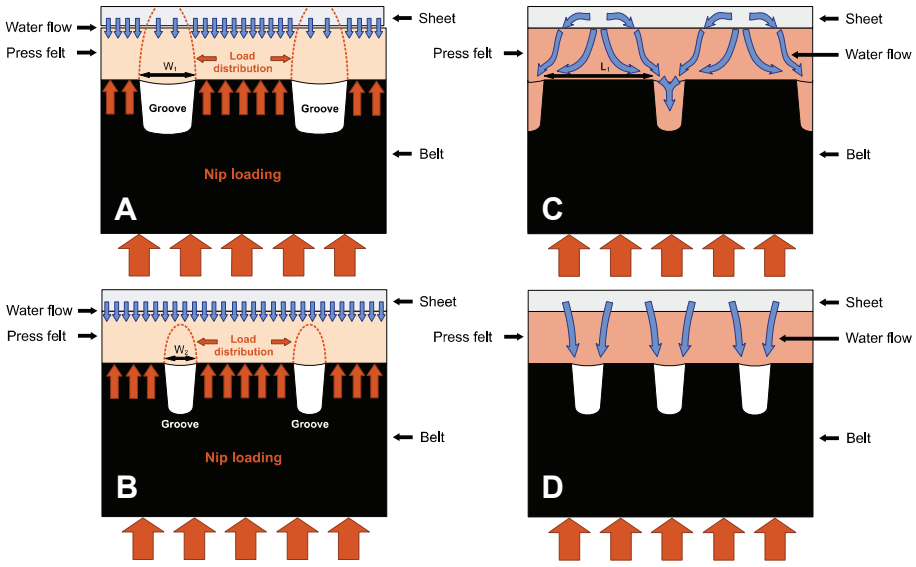
Two mechanisms cause marking

Based on laboratory tests and experience gained in practice, it is possible to distinguish two different mechanisms that cause marking. The most typical groove marking develops when the groove is very wide: the felt bends into the groove, and the press load decreases there which means that the web remains wetter, resulting in groove marking. It is possible to prevent this kind of marking with a belt with narrower grooves. (**Figure 19 - A and B**).

The other mechanism is linked with the distance between the grooves. If the distance is too long, i.e. the land is too wide, water in the web will try to flow to where the groove is. This causes flow marking in the web. It is possible to prevent this kind of marking with narrower lands. When trying to prevent marking, grooves that are as narrow as possible with lands that are as narrow as possible are an ideal combination (**Figure 19 - C and D**).

A) With wide grooves the press load will not come evenly over the belt to the sheet, because on the groove area the pressure against the sheet is lower than on the other areas. Thus, dewatering from the sheet to press felt is smaller and the small scale moisture profile in the sheet is uneven (= marking).

C) With a grooved belt the water can very rarely get straight from the sheet to the groove, as there's always some flow in cmd inside the felt. If the felt is old and compacted and the belt has wide lands, this flow may already start in the sheet causing marking.



B) When the grooves are narrower the press load comes more evenly over the felt and furthermore the dewatering from the sheet to felt is even, too.

D) Choosing the belt with narrow lands, the water doesn't have to travel such a long way to the grooves, and, thus, the risk of flow marking is smaller.

Figure 19. Mechanisms causing marking

Lands must not collapse under load

Shoe press belts are made of polyurethane, the hardness of which is typically 92-95 on the ShA scale, i.e. elastomer. The material places some restrictions on land dimensions. Lands must not collapse under the load, because this would mean losing the belt void volume, too.

In addition to the surface hardness on the ShA scale, the polyurethane matrix also has a significant effect on the load bearing capacity of the material. When changing over to narrower lands, the internal friction of the material has to be as low as possible in order to avoid the material's internal heat build-up under dynamic load.

Valmet has carried out numerous test-runs on the Rautpohja pilot machine in Jyväskylä, Finland, studying how different grooves function. In addition to this, various felt and belt combinations have been tested in a laboratory environment to study the marking tendency.

With the BlackBelt polymer, it is possible to make the lands as narrow as 1.3 mm while the groove depth is 1.3 mm without any risk of the lands collapsing. This was verified with a 1,500 kN/m load when the tilt (=pressure ratio between the shoe's ingoing and outgoing side) was 1.7. The nip flow grew linearly during the test run when the load was increased from 900 kN/m to 1,500 kN/m. If the lands collapse, nip dewatering will decrease when the load is increased. If the load is further increased, the sheet will start to get crushed.

It was possible to increase the groove width up to 0.8 mm with the EcoStar laminate-base felt without any marking. This was how the densely grooved BlackBelt HD (=high density) shoe press belt was developed. In it, the void volume has been maximized without any risk of marking, even on the most sensitive grades. With the above-mentioned values, the void volume amounts to 380 ml/m^2.

Case: marking had disappeared

The web of a paper machine that produces high-quality newsprint showed marking from all the grooved belts that had been run on it. After the installation of BlackBelt HD, all the visible marking disappeared. In fact, marking could no longer be found, not even in the laboratory (**Figure 20**)!

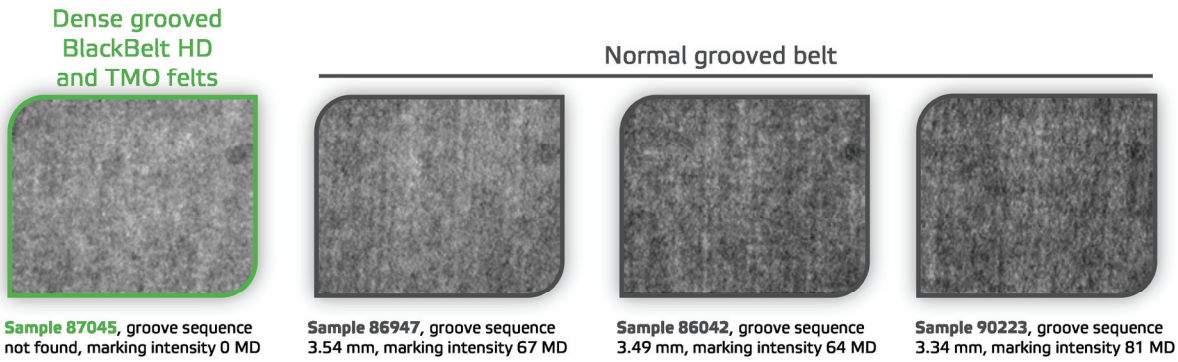


Figure 20. Marking analysis of customer improved news paper samples after processing with different belts

Thanks to Rautpohja's pilot machine it was possible to carry out numerous test runs in a short time and deliver a tested, well-performing product to the customer. In this way, there was no need to carry out test runs on the customer's machine as we already knew that the product would work.

Cooperation between Valmet's paper machines R&D and belt product development is very close. New developments are underway.

New BlackBelt E shoe press belt: E stands for extreme performance

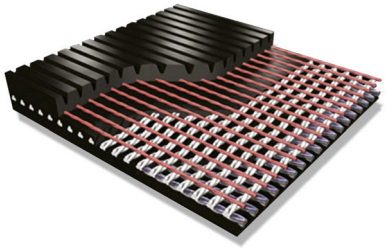


Figure 21. BlackBelt E cutaway showing yarn and grooves

The BlackBelt E (**Figure 21**) is an improved version of the BlackBelt shoe press belt that has been very successful at paper mills around the world ever since its introduction in 2008. The benefits of the BlackBelt E include longer life, less wear, even doctoring and better profiles. These factors all reduce the overall belt cost, which is a very important issue for mills in these economically tight times.

Machine-direction (MD) dimensional stability has been taken one step further in the BlackBelt E in order to better address the problems related to stretching and wear on demanding machines.

Uneven plastic MD stretching causes doctoring problems due to diameter variation, which prevents the doctor blade from moving across the belt surface evenly, resulting in poor profiles. The speed difference in the nip also causes mechanical belt wear. Elastic MD stretching also causes wear.

"The BlackBelt E features higher MD dimensional stability, which reduces the risk of permanent changes in the belt. It also has a very positive impact on wear resistance," says Ville Lahdensuo, Product Technology Manager, Belts, Paper Machine Clothing, Valmet. "Since the modulus of the reinforcement has been doubled, stretching in the BlackBelt E is only half of that of a standard BlackBelt. This means that the belt remains within the operating window more efficiently, and its dimensions do not change permanently."

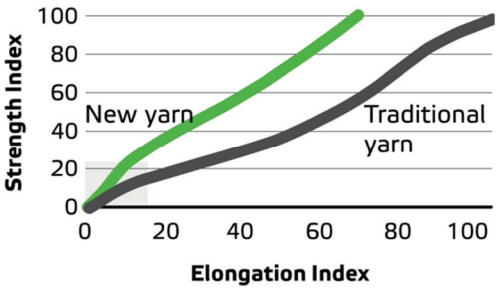


Figure 22. In paper machine conditions, the new yarn needs twice as much force to stretch over the yield point. Stretching over the yield point leads to irreversible deformation.

Also applicable to calendering

Another major improvement in the new belt is related to its ability to withstand heat. Its polyurethane material endures high temperatures of up to 130°C in continuous use without degradation. The synthetic yarns that reinforce the belt structure do not soften until the temperature reaches 120°C. Belts cannot usually be used in temperatures over 80°C.

"Since the BlackBelt E withstands high temperatures, it can also be used in calendering and other high-temperature applications," Lahdensuo points out.

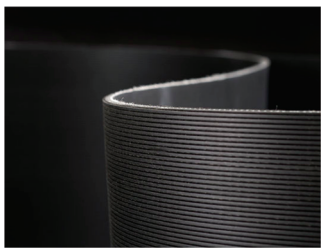


Figure 23. BlackBelt E resists stretching and withstands higher temperatures.

Positive feedback from customers

Just like its older brother, the BlackBelt E is available in smooth, grooved, semi-grooved, discontinuously grooved and high-density grooved designs, to fulfill the demands of each individual shoe press.

The new belt has been designed for all kinds of paper and board machines, but especially for the most demanding ones, such as wide printing paper and container board machines. According to Lahdensuo, the belt is also suitable for tissue machines. Tissue machines do not have high press loads

but they do have other issues with belts. "We have received only positive feedback from the mills where these new belts are being used and each customer has been able to improve shoe press performance."

Excellent experiences at Holmen Paper Madrid

Holmen Paper Madrid PM 62 is one of Valmet's long-standing belt customers. In summer 2012, the mill installed a BlackBelt E shoe press belt on the first press of this newsprint machine. Consequently, PM 62 ran a new world newsprint speed record of 2,030 m/min. The machine was also using Valmet's press felts at the time. And what's more, the BlackBelt E ran for 98.2 million nip cycles, which makes it the longest ever running shoe press belt on PM 62. Congratulations to everyone at Holmen Paper Madrid!"

New production line inaugurated

The demand for all products in the BlackBelt family has been growing steadily over the past years. To increase shoe press belt production capacity, Valmet built a new belt casting line in Tampere, Finland, which was inaugurated during the Clothing Days seminar in February 2013.

Non-marking BlackBelt HD family grows

In conjunction with the development work on the BlackBelt E shoe press belt, Valmet has expanded its range of high-density (HD) grooved surfaces that are available for the standard BlackBelt and the BlackBelt E. They all prevent marking efficiently and improve water removal from the web.

There is now a high-density option for machines that require a larger void volume, such as marking-prone board machines. And some very good results have also been gained with HD on tissue machines.

	BlackBelt HD 380	NEW: BlackBelt HD 420	NEW: BlackBelt HD 460
Grooves	0.80 mm	0.90 mm	1.0 mm
Lands	1.3 mm	1.3 mm	1.3 mm
Void Volume	380 g/m^2	420 g/m^2	460 g/m^2
Uses	Fine paper and tissue machines, also other machines making light and sensitive (=marking-prone) paper	Lightweight mechanical paper grades in the 2nd press of OptiPress or similar presses	Newsprint and packaging board machines in the 1st and 2nd press of OptiPress or similar presses

Table 4. Meet the members of the BlackBelt HD family

Summary

Valmet's press fabrics have proven to be reliable, cost-effective and long-lasting in demanding mill situations. Fabric development continues at Valmet's R&D facilities with new additions to the shoe press belt family – BlackBelt HD and BlackBelt E. Valmet field service engineers have extensive experience in fabric installation, monitoring and troubleshooting that help mills achieve the best return on investment.

This white paper combines technical information obtained from Valmet personnel and published Valmet articles and papers. Valmet provides competitive technologies and services to the pulp, energy and paper industries. Valmet's pulp, paper and power professionals specialize in processes, machinery, equipment, services, paper machine clothing and filter fabrics. Our offering and experience cover the entire process life cycle including new production lines, rebuilds and services. We are committed to moving our customers' performance forward.