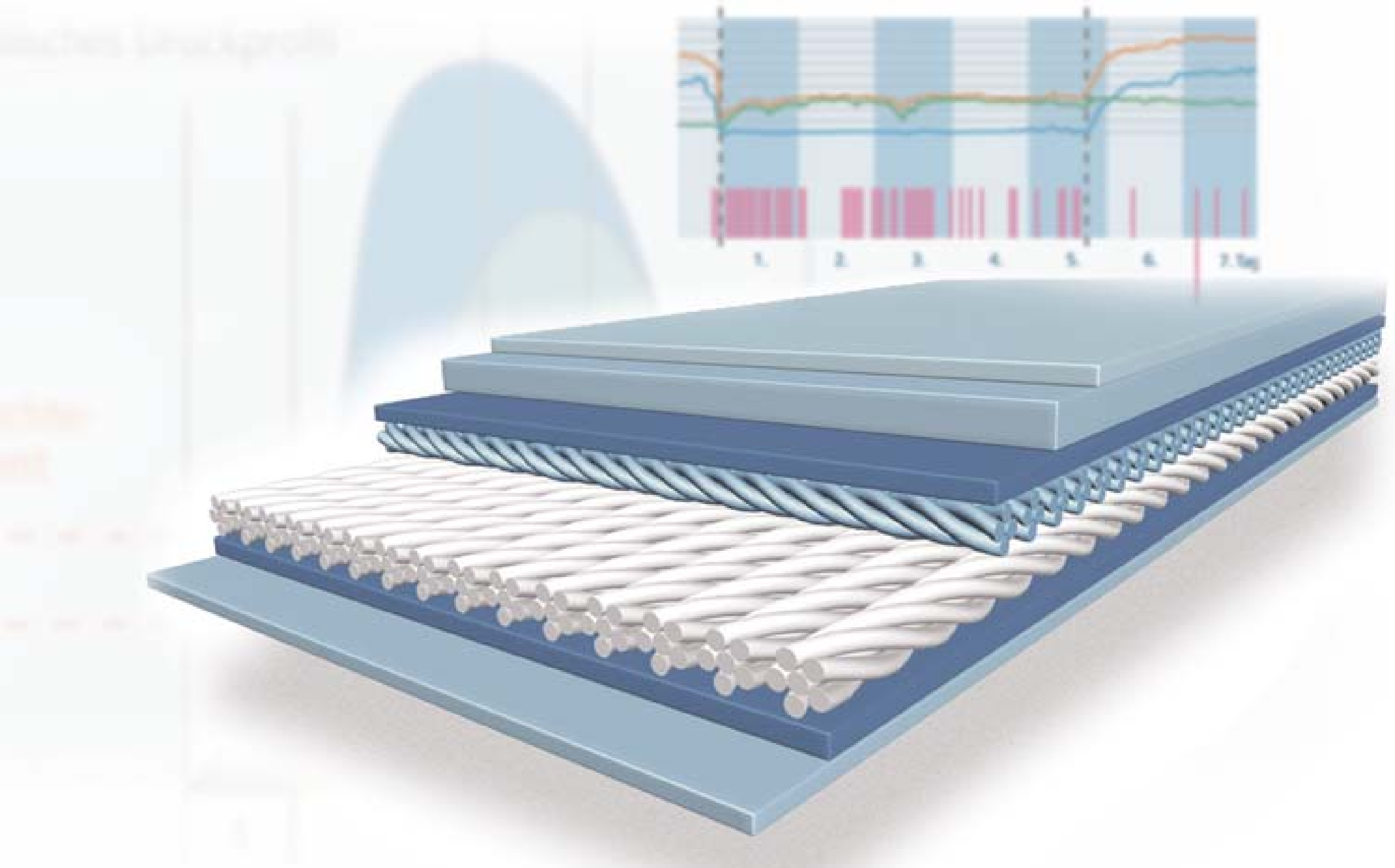

Press Release

Influence of vacuum capacity on press dewatering and energy consumption

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Influence of vacuum capacity on press dewatering and energy consumption

Introduction

What are the requirements for optimal press dewatering? The paper maker and the felt supplier should jointly select a felt construction, which is based on the data obtained from dewatering measurements.

Dewatering measurements show clearly the differences in the behaviour of different felt constructions. They also enable the vacuum capacity to be controlled, which can have a considerable influence on energy costs.

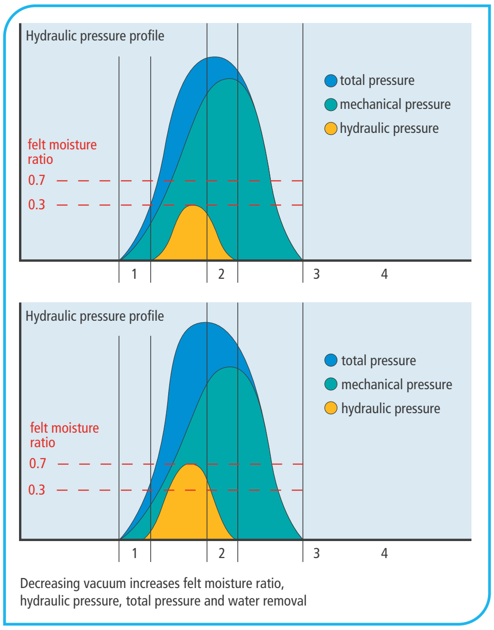
Just as important as an optimal felt construction and control of the vacuum capacity is the trouble-free operation of the rolls and belts. As the water is removed from the paper sheet, it should also immediately be removed from the grooves and drillings in the press roll or belt. It is absolutely essential that water is prevented from flowing back into the nip.

How much vacuum capacity is needed for a felt? What is the correct vacuum level? These questions are frequently asked by paper makers, felt suppliers and machine builders.

Dewatering efficiency in the nip – theoretical background

The vacuum capacity of the Uhle box has a significant influence on the water content of the felt. The water content of the felt in turn influences the total dewatering performance of the press through the change in the hydraulic pressure. The higher the felt water content, the higher is the hydraulic pressure. Ill.1 shows these relationships also in the context of the felt moisture ratio evaluation (Water Content [g/m^2] : Felt Weight [g/m^2].

A reduced Uhle box vacuum increases the felt moisture ratio. As a result a higher hydraulic pressure can develop in the nip. At the same time the nip length is extended. A saturated felt in the nip is less compressible than a felt with a lower felt moisture ratio. Consequently, because of the earlier development of higher hydraulic pressure, the dewatering process from the sheet can start earlier than would be the case with less saturated felts entering the nip. Such felts must first be compressed during the nip pass before the dewatering process can commence.



Ill.1 Felt moisture ratio (Dr Gilles Duquette)

In example Ill.1 the felt moisture ratio was increased from 0.3 to 0.7, which also increased the hydraulic pressure in the nip and started up the dewatering process at an earlier point. This leads to a higher level of dewatering. It follows that a felt which is too dry can not promote the dry content after the nip.

On the other hand a felt which is too wet can bring the danger of crushing problems, particularly if the water is not extremely effectively removed from the grooves and drillings of the roll and belt.

In practice this means: If a dry felt enters the nip, the felt takes up the water from the sheet. Part of the water is transferred by the felt into the roll and belt grooves and drillings. Finally, the Uhle box reduces the water content of the felt to its initial level of saturation.

Influence of vacuum capacity on press dewatering and energy consumption

If a sufficiently saturated felt enters the nip, the water is pressed out of the sheet, through the felt and into the grooves and drillings of roll and belt. In this case the much greater volume of water is thrown into the save-all. This means that only an adequately saturated felt can achieve an effective nip dewatering.

Dewatering efficiency in the nip – practical examples

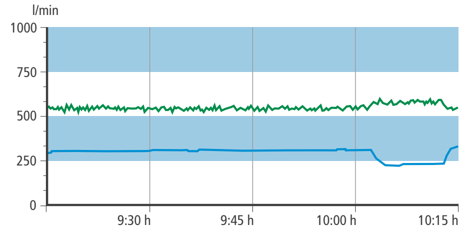
An unhindered water flow in the nip through the felt and into the grooves or drillings of the press roll and belt is the best precondition for maximum dewatering. Such a water flow is assisted considerably by the cleanliness of the felt. It is therefore particularly important that grooves and drillings are completely free of water before they enter the nip. If this is not the case, the take up volume for the water could be too low, creating the risk of crushing. That means: To achieve maximum dewatering a faultless doctoring operation must eliminate the water from the roll and belt surfaces as well as from the grooves and drillings.

With the “Air Blade” doctoring system from Runtech this can be achieved more perfectly and efficiently. The water film is completely blown away. Grooves and drillings are blown totally empty and cleaned by the Air Blade. The result is both a permanently even and maximum void volume across the roll or belt width. Positive effects: More even profiles, increased nip dewatering, better dry content, possible reduction of Uhle box vacuum, reduced felt wear.

In addition the possible vacuum reduction can lead to significant energy savings, both in the vacuum system itself and also in the press drive.
Ill.2 shows clearly that the nip dewatering is significantly higher with the Air Blade in operation, than when it is switched off. With the Air Blade in operation the Uhle box dewatering is somewhat lower. The end result is an increase in total dewatering of 6-7%.

Case study – 2nd press grooved roll

Clean roll, more dewatering – better dryness



Air Blade		Time	l/min	Total l/min
ON	uhle box save-all	to 10:03 to 10:03	523 288	811
OFF	uhle box save-all	10:03 - 10:12 10:03 - 10:12	549 210	759

Save-all dewatering increased 78 l/min (approx. 35 %)
Total dewatering increased 6-7 %

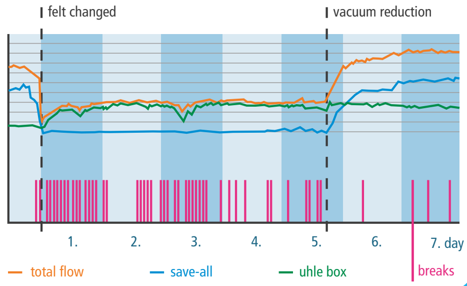
Ill.2 Air blade doctoring example on OptiPress machine

The appropriate vacuum capacity for a felt can be established with the help of dewatering measurements and adjustments to the vacuum level. This is the only realistic possibility of avoiding operating with felts which are too dry.

Ill.3 shows a good example of what can happen when too high a vacuum is applied to a new felt. Here can be seen that after the installation of a new felt – initially at the same vacuum level as the “old” felt – the dewatering falls markedly.

At the same time the break rate increases drastically. After reducing vacuum towards the end of the 5th day, nip dewatering and total dewatering climb steeply to a higher level than with the previous “old” felt. The break frequency is substantially reduced.

1st press felt – breaks – 7 day trend after felt change



Ill.3 The influence of the nip dewatering on the web breaks

It is revealing that the dewatering efficiency of the Uhle box is unchanged after the reduction in vacuum. This confirms the comments made in connection with Ill.1.

The nip dewatering can be correlated with the felt moisture ratio. Without vacuum control the new felt carries the water predominantly to the Uhle box; the total dewatering is minimal. A high break frequency is the result.

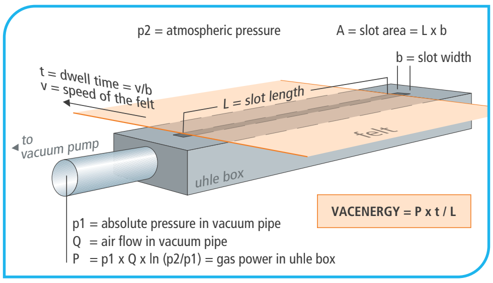
Many observations have been made on how much vacuum a felt needs during its life - and when. Practical experience shows that that the total dewatering remains constant or even reduces when the vacuum level is increased to over 50 kPa. This means that a high vacuum has no positive influence on an old felt.

Vacuum capacity for felt conditioning

The influence of the water content in the felt entering the nip on dewatering has been explained above. After more than 200 felt measurements on all types of machines it can be said that: Theory and practice confirm that the felts should not be allowed to run too dry.

In order to compare suitable vacuum capacities for different felts from case to case, the value "VACENERGY" was evolved.

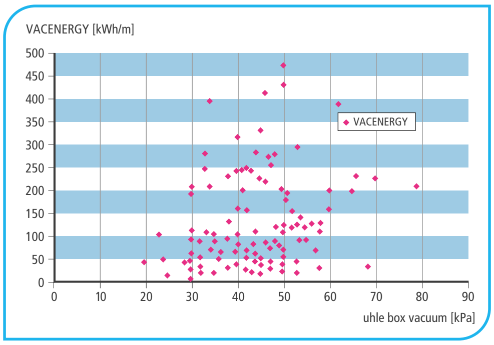
This value is the result calculated from the Vacuum Efficiency in the Uhle box, multiplied by the Dwell Time of the felt over the Uhle box slot and divided by the Open Slot Length of the Uhle box (Ill.4).



Ill.4 Vacuum capacity of the felt – VACENERGY

VACENERGY provides no information about the degree of dewatering, but can only be applied to the comparison of vacuum capacity.

Ill.5 highlights the correlation between the measured vacuum levels of the Uhle boxes and the vacuum capacity values of the VACENERGY. The measurements were carried out on felts running on various printing paper and board machines with production rates of 10-70 t/h.

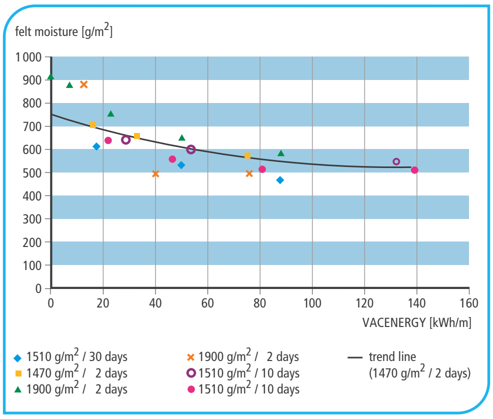


Ill.5 Measured vacuum levels vs. VACENERGY

Big variations exist between vacuum levels and vacuum capacities (VACENERGY values). Slow running machines have typically a higher vacuum capacity (VACENERGY value) as a result of the greater dwell time of the felt over the Uhle box slots. It is obvious, however, that the vacuum capacity of the Uhle box can vary significantly, without having any influence on the production volume.

Ill.6 shows the test results from the correlation between the water content of the felt before the nip and the VACENERGY values of the vacuum capacity. The machine speed was about 500 m/min. On increasing vacuum capacity from 50 kWh/m to 100 kWh/m the water content of the felt reduced by only 60 g/m^2. This reduction had only a marginal effect on felt performance. At a vacuum capacity of over 100 kWh/m no additional reduction in water content was achieved.

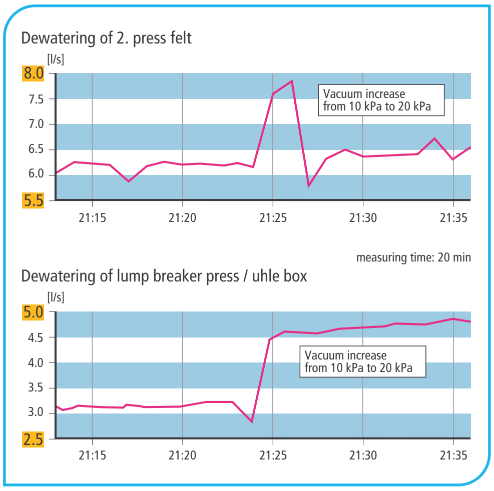
In this trial 140 kWh/m equated roughly to the 200 kW performance of the water ring pump motor. It should be noted that it was possible to run the felt in this trial completely without the Uhle box and that this had no influence on the dry content. The total water was removed by nip dewatering via the save-all. Without Uhle box the felt moisture ratio was about 0.5 – i.e. far below the theoretical maximum of 0.7.



Ill.6 VACENERGY vs. Felt Moisture before the nip

On lower speed machines with plain press rolls the water has to be removed by the Uhle box. If the felt is too wet, the nip floods. Ill.7 shows such a situation on a pulp dewatering machine.

In this case study the nip flooded at a vacuum level of 10 kPa. After raising the vacuum level to 20 kPa dewatering through the Uhle box increased significantly and nip flooding disappeared.

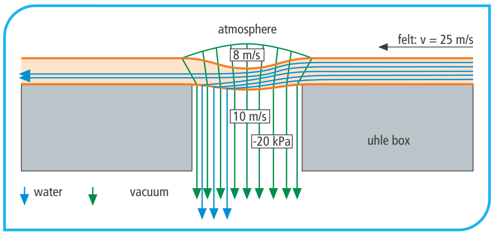


Ill.7 Influence of the increased vacuum level on the dewatering (pulp machine)

Uhle box performance on high speed machines
A reminder: In Ill.3 the typical behaviour of an old and a new felt under the influence of varying vacuum adjustments was shown. The old felt tended towards nip dewatering, the new felt transferred the water (at first) mainly to the Uhle box. Only after reducing the vacuum did the new felt dewater at the nip. When a felt gets older, it would appear to be impossible to achieve dewatering via the Uhle box, even with the vacuum at 80 kPa.

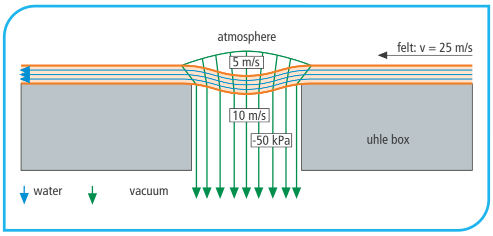
The problem can be explained as follows: The speed of a felt is, for example 25 m/sec. The felt contains water with the known density of 1000 kg/m³. It is in fact impossible that the water in the felt could be diverted at an angle of virtually 90 degrees into the slot of a Uhle box simply by the force of a suction air flow of 5-15 m/sec with a density of only 1.1 kg/m³.

In Ill.8 the behaviour of a new felt over the Uhle box slot is shown. The vacuum here is 20 kPa. The pressure difference between atmospheric pressure over the Uhle box slot and the vacuum in the Uhle box somewhat compresses the felt structure. This volume reduction in the felt pushes the water to a certain extent into the lower part of the felt as far as the roll side and from there into the Uhle box slot – thus achieving Uhle box dewatering.



Ill.8 The behaviour of a new felt under the 20 kPa vacuum

When the felt has run for longer and has lost its initial openness and especially its resilience the situation is changed as follows: The press nip applies 10-100 times more pressure on the felt than the vacuum in the Uhle box can achieve. Over a period of time the felt has been so heavily compacted by the nip pressure that the pressure difference between atmospheric pressure and Uhle box vacuum can no longer press the felt any "thinner". Ill.9 shows the behaviour of an old felt over the Uhle box slot. Even the suction air flow produced by a vacuum of 50 kPa is on its own not capable of pulling the water out of the felt and into the Uhle box slot. This is the reason that with older felts very poor or even no Uhle box dewatering is obtained. It should also be borne in mind in this context that the air velocity over the Uhle box slot reduces with increasing vacuum (see Ill.8 and 9): Air is less dense when the vacuum is higher.



Ill.9 The behaviour of an old felt under the 50 kPa vacuum

In several case studies many customers have made the experience that a high nip dewatering keeps the felt cleaner (– the water flows through the felt into the nip –) and at the same time provides a higher total dewatering.

The Uhle box serves primarily to keep the surface of the felt clean. In some cases operation without Uhle boxes led to even better results.

The facts: High vacuum capacity provided no advantages in felt cleaning on high speed machines, but led only to increased felt wear (reduction in life). The energy costs for vacuum pumps and for the press drive increased with the vacuum level, without bringing any additional advantages.

In order to achieve a high level of dewatering in the nip, the function of the dewatering and water removal elements is a priority. It makes no sense first to remove the water from the felt in the nip and then to allow it to flow back out of grooves and drillings. The Air Blade doctoring system is the only product which can thoroughly clean and totally empty the grooves and drillings of rolls and belts.

Also important in high nip dewatering is the optimal functioning and construction of the save-all. A splash back of the water or overflow resulting from inadequate acceptance or discharge must be avoided at all costs.

Costs of felt conditioning

Felt conditioning is a significant cost factor in paper manufacture. Costs result from the following aspects: Energy for vacuum pumps, lubricating and sealing water for vacuum pumps, vacuum pump maintenance, energy for press roll drive (the higher the Uhle box vacuum, the higher is the frictional resistance in the in the press section), the volume of shower water and the chemicals for felt cleaning.

By means of controlled application of of the Uhle box vacuum all costs associated with it can be reduced. It has already been pointed out that, taking the specified requirements into account, it is possible to run felts during their whole life on almost all paper machines with a vacuum level of 20-40 kPa.

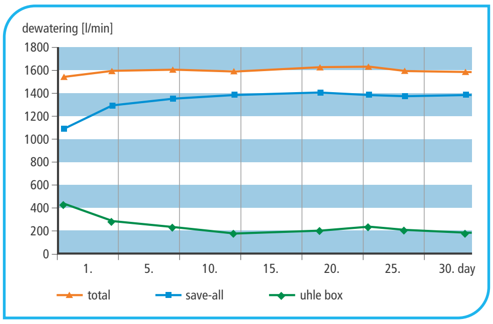
With a vacuum level of 20-40 kPa instead of 40-70 kPa the following advantages appear: Reduced felt wear, lower energy consumption for the press drive (about 50-150 kW per felt), savings in vacuum pump power (about 50-300 kW per felt) together with the more difficult to quantify (medium or long term) reduced pump wear, lower maintenance and reduced lubricating and sealing water usage.

These savings can best be obtained by regulating the vacuum pump revolutions and by the installation of a felt design which is able to start up immediately with high nip dewatering.

Case study: Newsprint at 1500 m/min with non-woven felts from Heimbach

The press section consists of a Metso SymPress 2 with a 4. free-standing press. The customer installed the Air Blade doctoring system for the suction press roll and the 3. press. At the same time the save-all in the 2. press was modified.
The optimal functioning of the doctors and faultless removal of the water permit the use of felts which transport a high volume of water to the save-all. As already mentioned both theory and practice show that felts with higher nip dewatering achieve better dry contents and at the same time to a large extent take care of their own cleaning.

During the life of ATROCROSS trials with high and low vacuum were carried out.



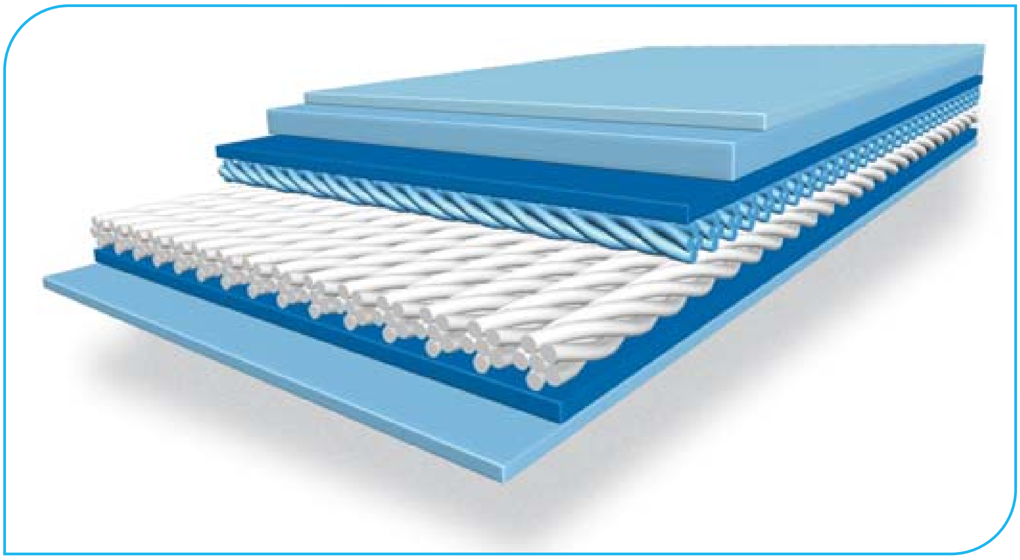
Ill.10 Pick-up felt dewatering during its life time

Because of the particular construction of the Non-woven Press Felts the Uhle box dewatering was only at low levels. After a week the dewatering was occurring almost exclusively via the nip (Ill.10) – irrespective of the vacuum level. The press could be run permanently with high nip dewatering at low vacuum levels without problems.

The felt design from Heimbach with its non-woven base construction reaches a maximum nip dewatering in the shortest time and thereby offers the paper maker a particularly fast start. The prerequisite for the basic advantages of this technology is the fact that the construction has no Z-direction yarn system and therefore no weave knuckles.

Furthermore, the base is composed of non-woven base layers, which as yarn substrates are aligned flat on top of one another in cross-machine and machine directions. In this construction a substrate batt is applied to each yarn substrate. By means of a special manufacturing process the individual parallel running yarns of the yarn substrates are stabilised with great precision.

The typical feature of the Heimbach non-woven base is the paper side yarn substrate aligned in the cross-machine direction (Ill.11).



Ill. 11 Non-woven felt from Heimbach

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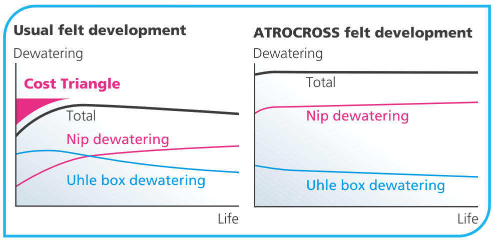
In this way the yarns operate as "Micro Foils", which "scoop" the water very fast and intensively into the inside of the felt. This leads to a high degree of saturation of the felt even at low specific pressures and additionally reduces rewetting. Only a saturated felt permits effective dewatering. For all these reasons ATROCROSS has proved itself as an extremely fast starter and an outstanding "Nip Dewaterer".

Particularly for fast machines the start up of a felt is of great importance. A high start up speed always means considerable production increase (Ill.12 "Money Triangle"). If a 10 m wide newsprint machine (45 g/m^2) as a result of optimal start-up dewatering can run 100 m/min faster, the gain in production amounts to about 65 tonnes per day.



Ill.12 Comparison: "Cost Triangle"

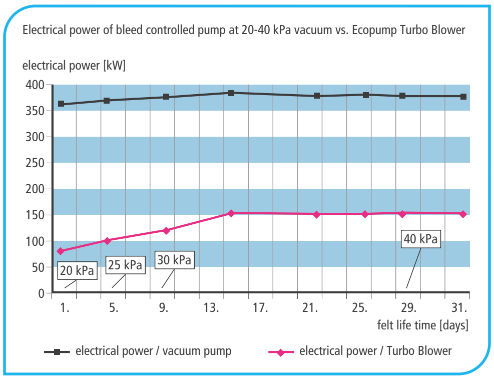
Energy cost savings

A high nip dewatering, a reliable doctoring and an effective save-all ensure that high vacuum is not necessary. Under these conditions the felt can be run throughout its whole life at 20-40 kPa vacuum.

Energy consumption of vacuum pumps

In the example described here the Uhle box was attached to an old water ring pump which needed 350 kW of electrical power and around 200,000 m^3 of sealing water per year.

For comparison a calculation is shown here in which the felt is operated with an Ecopump Turbo Blower (controlled revolutions) on which the vacuum ranged from 0 to 70 kPa. At a vacuum level of less than 40 kPa during the whole felt life enormous cost savings can be achieved (Ill.13).



Ill.13 Savings in the power consumption with the lower vacuum level

Annual savings

Vacuum energy 2256 MWh (~ 0.06 EURO/kWh)
Energy consumption savings EURO 135,000 ¤

Additional savings

- Water 200,000 m^3
  (no sealing water consumption)
- Lower clothing costs (reduced felt wear)
- Fewer felt changes
- Reduced power consumption for press drive
  (through lower vacuum)

Summary

Really big savings can only be realised by optimising the dewatering in the press section, as explained here. Additionally, a reliable dewatering measuring system together with a suitable selection of clothing are indispensable.

Air Blade doctoring from Runtech, Turbo Blower from Ecopump and non-woven ATROCROSS felts from Heimbach can make an important contribution to an effective and economical optimisation of the press section.

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