Press Section | All Paper Grades

Press Release

The optimisation of sheet transfer from the forming section into the dryers

Status quo – possibilities for improvement – further development

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The optimisation of sheet transfer from the forming section into the dryers

Summary

The job of the press section is to create maximum sheet dewatering with the best sheet characteristics and first class runnability. When future paper machines are designed for even higher speeds, when "more difficult" raw materials are used and paper grades become ever lighter, then the operation of the "zone between pick-up from the forming section up to the pick-up into the dryer section" will determine to what extent success is achieved in protecting the sheet.

Modern press sections will increasingly be planned under those conditions which enable a significantly improved sheet transfer. But also in existing machines sheet transfer conditions can be substantially improved as shown in this report.

Introduction

Modern high speed paper machines are nowadays being built for speeds in the 1800-2000 m/min range. Productivity increases at present are in many cases achieved by increasing the machine speed. Therefore, it can be assumed that also in the future efforts will continue to be made to increase the paper machine speeds.

A speed increase necessarily requires an increase in the sheet tension. If the sheet on its way from the forming section to the dryers is not well supported by the machine clothing, its wet tensile strength is not sufficient to withstand the increased tension. Additionally, stock developments – increased filler content, more recycled fibre, new polymers etc., combined with the tendency to lower basis weights – combine to increase the necessity for better sheet control.

Therefore as precondition for the achievement of a lasting and successful speed increase, available technology is increasingly highlighted: "The Optimisation of Sheet Transfer from the Forming Section into the Dryers." The freshly formed sheet is largely supported and carried from the headbox, through the forming section and the press section up to the last press by the fabrics and felts of the paper machine clothing. However, on many machines there are clothing free zones, the so-called "free" or "open draws". In some cases they can already be found in the press section between a third and a free-standing fourth press, respectively between the press section and the dryers. Through these zones of open draw the sheet must be conveyed, "transferred" into the dryer section.

This involves the risk that the fresh, still wet, sheet – unsupported by clothing – does not have the necessary tensile strength, and as a result, it breaks. Any further increase in speed to avoid this problem is impossible. A speed reduction may even be unavoidable in the interests of overall runnability.

For these reasons the reduction or elimination of the open draws is recommended. In addition the subject of "Transfer Optimisation" involves further actions for the solution of other aspects of the total problem. In the following the status quo of the transfer, the possibilities for its improvement and further development are considered.

1. Sheet transfer conditions

In the pick-up position the transfer of the still wet and delicate sheet from the forming fabric to the pick-up felt mostly takes place with the help of a suction roll. Afterwards the sheet is supported by the clothing through the press section depending on the relevant press configuration. Now in order to take the sheet without risk through a (possibly) open draw in the press section or through the open draw to the dryers, attempts must be made to achieve balanced running conditions. These include, for instance, adequate tensile strength of the sheet for its separation from the carrying rolls without sheet flutter or breaks in the open draws. Additionally, the wet strength must be sufficiently high to permit the highest possible speeds and the necessary tensions.

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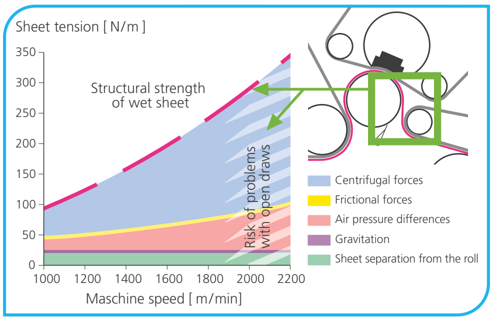
A further risk lies in the possible structural damage to the still wet, unprotected sheet which can be caused by too high tensions in the open draws. Quality problems occurring at this stage can lead to later difficulties in production on the machine or in subsequent conversion or in printing.

In order to permit the sheet to survive these conditions undamaged, not only the newest technologies in sheet formation and tensile development are required, but also a "concerted action" for the optimisation of all influencing parameters.

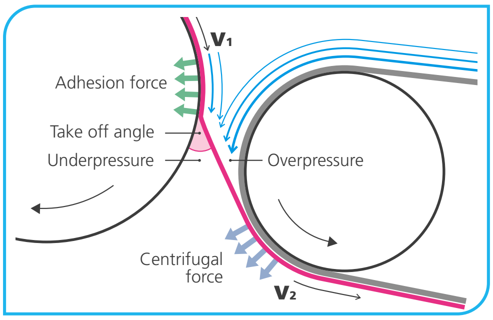
These include sheet tension, air pressure differences, sheet pick-up, dry contents and clothing influences – to mention the most important.

2. Sheet tension at transfer and the influences affecting both

Normally, steady increases in machine speed require appropriate increases in sheet tension. In addition, both tension and sheet transfer are influenced by further factors (Ill.1,2).



Ill. 1 Transfer – Speed: Sheet tension



Ill. 2 Additional influences on tension and transfer

These factors are: centrifugal forces, friction, air pressure differences at the take-off point of the sheet, gravitational and adhesion forces and also the tensile strength of the sheet. They underlie, at least in part, the influences of the stock, the paper grade, the basis weight, the influences of the sheet moisture

content, the surfaces of the paper guide rolls, the influences of fabrics and felts and those of dewatering or dry contents after the forming and press section. The above mentioned factors are also affected by the operation of technical installations designed to support sheet transfer such as suction zones, blow boxes and air curtains.

Some of these tension and transfer relevant influences are negatively increased in their effects by the presence of open draws and their length. The sheet, therefore, needs a higher tension to "overcome" a longer draw than a shorter one. Closed draws on the other hand only require a comparatively low sheet tension.

In addition to the above influences on the tension, additional tension is produced by differences in the drive speeds of the rolls and/or cylinders. Such speed differences – of more than the absolute minimum – are not of interest to the papermaker. Even so, a long open draw can require a speed difference of 3-4%. With increasing sheet tension their negative influence on the sheet characteristics become significantly greater.

With this flood of influences and their variable mutual relationships the question has to be asked: Which tension and transfer relevant influences can be varied to achieve a better sheet transfer?

The answers to this bring some clarity to the complex relationships: The sheet tension can be reduced – even when speed is increased – if all variable tension-intensive influences on the sheet are either eliminated or significantly reduced – particularly the open draws.

The centrifugal forces increase exponentially with machine speed and are therefore the dominant additional influence on sheet tension (see Ill.1). However, they can scarcely be influenced. Friction should usually be so low that its influence can be disregarded. Gravitational forces are only of significance with heavier grades.

The air pressure differences at the take-off point before and after the sheet (seen in running direction, Ill.2) can however be modified in favour of a reduction in sheet tension and a safer sheet transfer. Also the adhesion forces – those forces necessary to be got over for the separation of the sheet from the carrying roll – can in part be influenced in favour of transfer optimisation.

In summary the following influences can be varied in favour of better sheet transfer: the sheet tension / open draws, the air conditions at the take-off point of the sheet and to a certain extent the adhesion – together in part with the influences which affect the tensile strength of the sheet.

The possibilities of positive change to these influences are now dealt with in the following sections.

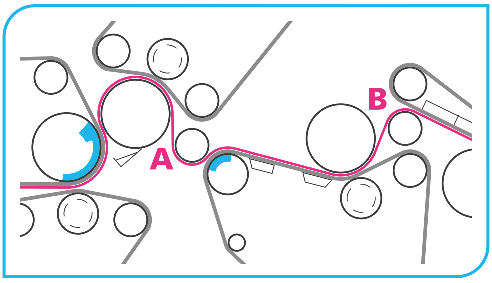
3. Possibilities of reducing open draws

In the following a number of examples of possibilities for reducing open draws described in principle:

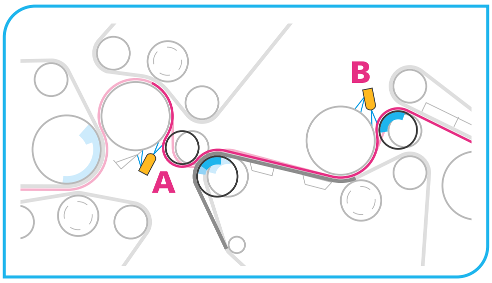
Central roll free-standing 4. Press (Ill.3, Point A)

Shortening the open draw to the 4. Press by repositioning the hitch roll and the suction transfer roll, plus possible air curtain (Ill.4, Point A)

Here the hitch roll is pushed up close to the central roll so that it functions as a take-off roll and substantially reduces the open draw. An additional air curtain (eg. RS AIR CURTAIN from Runtech Systems) can be installed for better separation of the sheet from the central roll. The 4. Press suction transfer roll must also move to close up the draw.



Ill. 3 Paper sheet with two open draws



Ill. 4 Paper sheet with two significantly reduced draws

In contrast to the original situation the vacuum zone should be positioned so that it commences at the apex of the hitch roll and the suction transfer roll and its remaining area in the running direction is located after the apex of both rolls. This prevents vacuum before the apex creating an additional airflow between the sheet and the press felt.

Free-standing 4. Press Dryer Section (Ill.3, Point B)

Exchange of guide roll for suction transfer roll plus possible air curtain

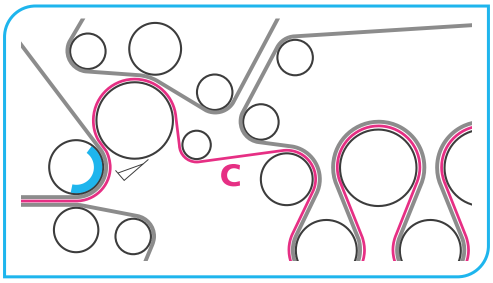
(Ill.4, Point B)

Also in the situation shown here, the vacuum zone should start at the apex of the 4.Press roll and the suction transfer roll. To ensure sheet take-off the installation of an air curtain is recommended.

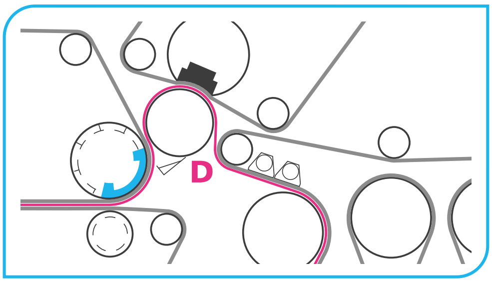
3-Nip-Press, Central Roll Dryer Section (Ill.5, Point C)

Significant reduction of open draw by repositioning of hitch roll plus possible air curtain combined with substantial shortening of open draw by repositioning of 1.dryer cylinder and a fabric roll

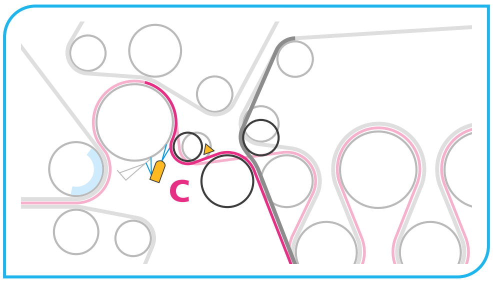
(Ill.6, Point C)



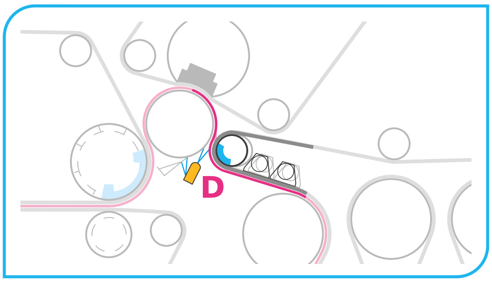
Ill. 5 Paper sheet with two open draws



Ill. 7 Paper sheet with one open draw



Ill. 6 Paper sheet with two significantly reduced draws



Ill. 8 Paper sheet with one significantly reduced draw

In the example suggested here the hitch roll is placed close to the central roll and functions as a take-up roll. Sheet separation should be secured with an air curtain. In addition the extremely long open draw to the first dryer cylinder can be significantly reduced so that this cylinder is positioned as close as constructively possible to the take-off roll. The removal of the sheet should be supported by an air doctor.

3-Nip with Shoe-press, Central Roll Dryer Section (Ill.7, Point D)

Exchange of 1. fabric roll for a suction take-up roll positioned against the central roll, plus possible air curtain

(Ill.8, Point D)

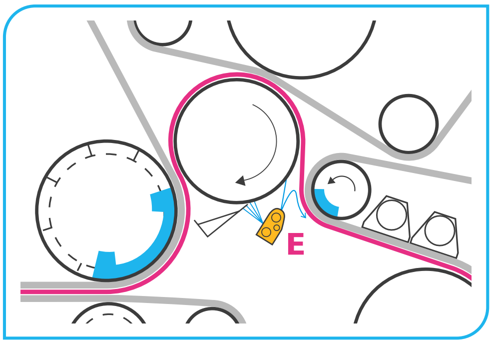
Also here: The vacuum zone should begin at the apex of both rolls in the running direction. An air curtain can assist sheet separation for the central roll. The two blow boxes must be positioned close to the suction take-off roll.

3-Nip Press, Central Roll Dryer Section

Installation of fabric roll with vacuum zone together with an air curtain

(Ill.9, Point E)

Sometimes for machine design or other reasons it is not possible to reduce an open draw by repositioning rolls. In this case it is recommended to replace the plain fabric roll with one with a vacuum zone. To support the sheet take-off and to stabilise the sheet in the open draw, an air curtain should in this case definitely be installed.



Ill.9 Paper sheet with one open draw: protected transfer

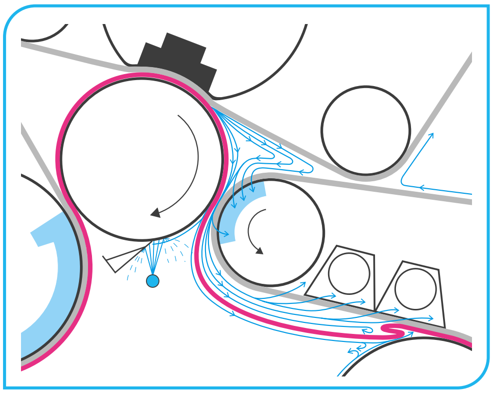
3.1 Adjustment of take-off roll suction zones

In the descriptions of Illustrations 4, Points A and B and 8, Point D it was pointed out that in the event of incorrectly positioned vacuum zones, loss of vacuum could occur between the clothing or the roll surface and the sheet. Ill.10 shows the resulting air flow pattern.

The optimisation of sheet transfer from the forming section into the dryers

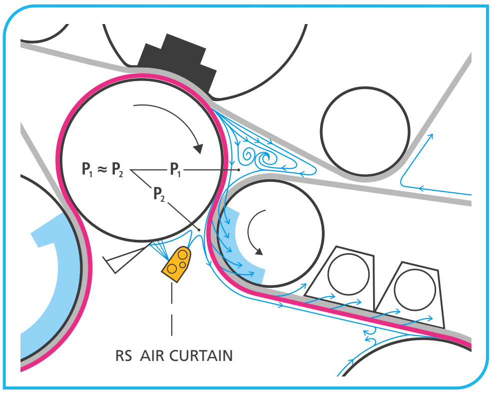
During the production process all moving elements carry a layer of air (boundary air layer) with them in the same direction of run. This also applies to completely plain rolls. Depending on surface characteristics and internal structure (in the case of clothing) of the moving element this air layer can be "thick" and almost as fast as the moving surface, or also "thinner" and also slower. With increasing distance from the moving surface the speed of the air layer reduces.

In Ill.10 the suction zone is clearly incorrectly positioned. It commences – seen in the running direction – significantly before the apex of the central roll and that of the take-off roll. In this area the suction zone pulls air through the dryer fabric and encouraged by the airflow into the roll nip. Its intensity is strengthened by the direction of the boundary air layer.



Ill.10 Vacuum loss from badly positioned suction zone

As the two rolls do not form a "true" press nip, but only a take-off point for the sheet, there is so much space between the rolls that a significant proportion of the air pulled into the nip in fact passes through it. Inevitably this volume of air after the nip is located between the sheet and the dryer fabric. Because this mass of air can scarcely be removed by suction from the short vacuum zone area after the apex, it remains in the "inflated" free space between the fabric and sheet until they contact the first cylinder. The sheet therefore has a longer route to the cylinder during which it is stretched and extended with the possible risk of creasing. Ill.11 shows the correct positioning of the suction zone. It commences ideally just before the apex of both rolls. Then the very small amount of air pulled into the nip can be removed before the apex. At the same time the suction zone pulls the sheet from the central roll on to the dryer fabric. The paper sheet as a result lies securely on the dryer fabric so that both can run on to the first cylinder without problems.



Ill.11 Air situation with correctly positioned suction zone

In order to ensure even more secure transfer when pressing the sheet against the clothing, a special "Air curtain" can be installed: AIR CURTAIN from Runtech Systems (Ill.11). This unit produces an "air curtain" by blowing continuously into the nip thus helping separation of the sheet from the central roll (reduction of tension). At the same time in the same position in the nip underpressure present in the nip is evened out and adjusted to the higher air pressure in the nip before the apex: P1~P2. The combination of the adjusted air pressure with the vacuum from the correctly positioned suction zone already during the transfer process further ensures that the sheet is pressed firmly to the dryer fabric.

The RS AIR CURTAIN – instead of the shower usually installed in this position – performs the dual function of lubricating and cleaning the central roll and doctor (Ill.11). A self cleaning system prevents contamination by paper stock or possible breaks and is connected to the break sensor of the machine.This detailed description shows the significance for the papermaker of the influence of small areas, such as suction zone positioning, on the transfer – in comparison to the complexity of the whole machine.

4. Influence of clothing on sheet transfer

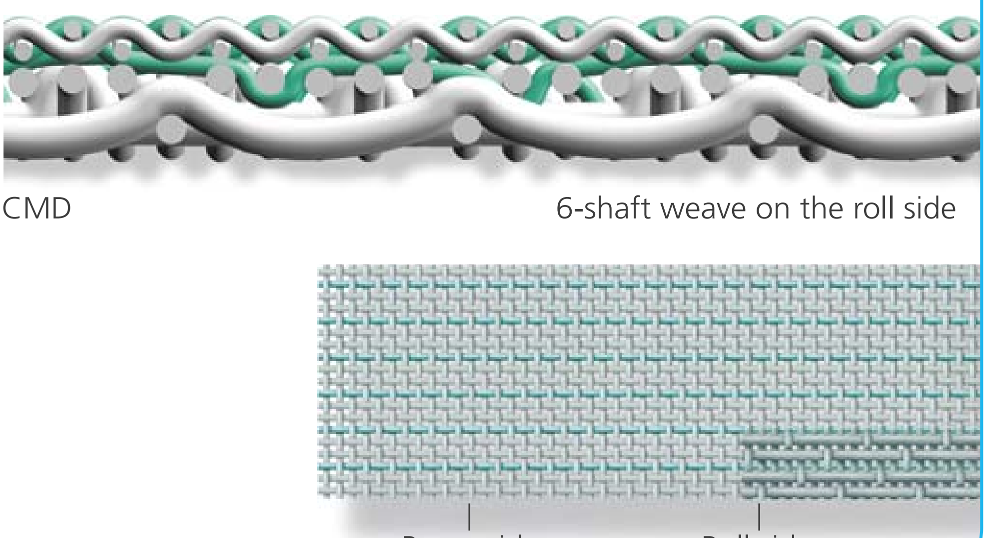
The prerequisite for a distinct and enduring optimisation of sheet transfer during production is the reliable tensile strength of the sheet. The basis for this is established in the micro and macro areas of sheet formation. By far the major part of dewatering occurs in the forming section and it is therefore here that the greatest influence on the technical values of the sheet is present. The sheet formation process on the forming fabrics flows from the formation and retention phases into the pure dewatering phase of the formed fibre mat. For the optimal transition between these phases the characteristics of the forming fabrics are of great significance.

In the press section the pick-up felt, in addition to its pick-up function from the forming section, takes on the dewatering requirements of the 1. and 2. presses. It determines in conjunction with the other press felts the dry content of the sheet. This in turn determines the draw tension of the sheet and also the adhesion at transfer.

4.1 Influence of forming fabrics on sheet tension

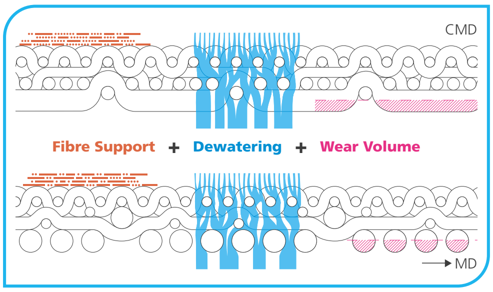
Forming fabrics have to ensure an excellent retention and formation with the best possible dewatering. The increasing proportion of fines in virtually all paper grades requires the forming fabric to have the highest retention capacity. This retention capacity requirement demands appropriately small mesh dimensions on the top side of the fabric. On the other hand the demands on dewatering efficiency and high dry content at the end of the forming section require a fabric structure which allows a high water flow. This means that the fabric at the same time has to be open.

These apparently opposing requirements – high retention, but open fabric structure – are met equally with the modern SSB (Sheet Supporting Binder) Fabrics. The SSB fabrics of the PRIMOBOND range from Heimbach have a very fine upper layer (Ill.12) providing both a high level

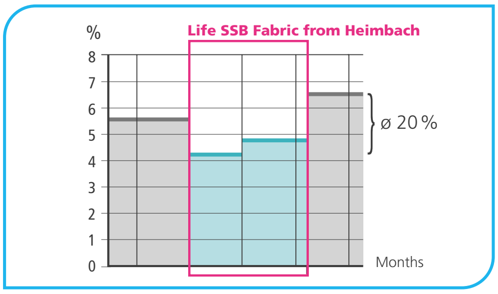


Ill.12 Ultra-fine SSB Fabric construction (PRIMOBOND.XF from Heimbach)

of fibre support and an active initial dewatering on the paper side. The lower layer ensures the continuation of the downward dewatering (Ill.13) whilst also providing optimum CD stability. The result is a balanced fabric structure which gives an even moisture profile and contributes to a high sheet tensile and minimises the break frequency (Ill.14).



Ill.13 SSB Fabric concept from Heimbach



Ill.14 Fewer breaks

Expectations on paper quality on the one hand and runnability on the other continue to increase. Therefore the Heimbach Group have brought a unique ultra-fine fabric structure on to the market: PRIMOBOND.XF. This product reaches highest levels of fineness. This is achieved by the use of a special, extremely thin monofilament material (patented engineered polymers).

The result is a superfine fabric surface with an FSI (Fibre Support Index) of > 215 = more than 1700 points of contact (Ill.12). Very good sheet characteristics such as formation and CD profiles combine with the high dry content to ensure trouble free transfer to the press section.

Quite independently of any clothing, an area of forming section equipment should be mentioned, which is relevant to the subject of sheet transfer: "Edge Trim Equipment: Demands – Operation – Performance."

"In fact the successful operation of a paper machine depends to a not inconsiderable extent on the trouble free functioning of the edge trims. The benefits of this include: lowest possible break frequency, trouble free transfer at the pick-up, the prevention of both sheet drop-off and edge trim following." The above is the introduction to a report under the above title in italics (TASK Information Forming Section No. 2) to be downloaded under: www.heimbach.com, or on telephone request from Heimbach.

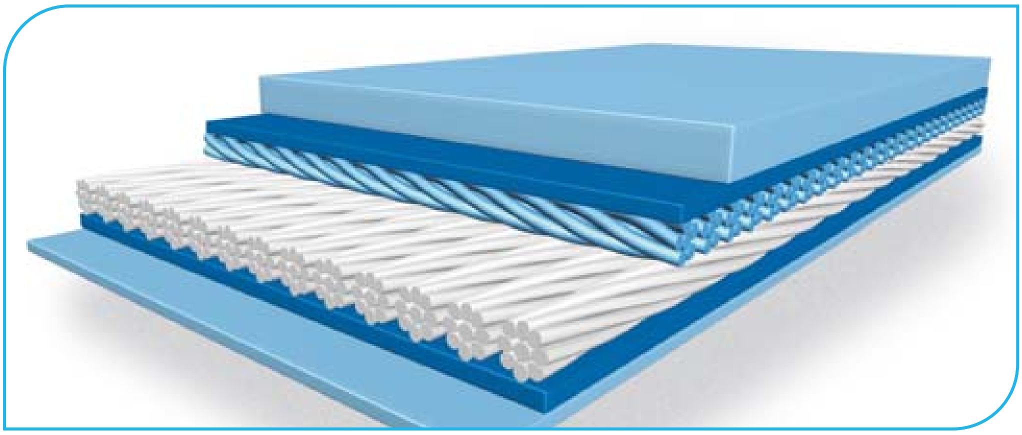
4.2 Influence of press felts on transfer

The press section clothing has a more direct influence on transfer than the forming fabrics. This applies initially to the transfer function of the pick-up felt, which will not be pursued further in this paper. Much more, the subject of "dewatering" with the associated subjects of "dry content, sheet strength" and "tension" together with "adhesion" and "sheet release" should be examined – under the requirement for optimal performance and adjustment of the machine equipment.

The dewatering efficiency of the press felts determines substantially the dry content of the paper sheet. This dry content is to a significant extent decisive for the sheet strength and for the possible degree of sheet tension – in effect therefore for the production speed. The higher the dry content the lower the draw tension needs to be in order to separate the sheet from the carrying roll (adhesion, angle of separation). Alternatively, the higher the dry content the higher the tension applied to the sheet can be.

As a result the speed can be increased. This in turn permits an increase in the dewatering efficiency… a beneficial spiral which only ends when the machine or the clothing has reached its limits.

The optimisation of sheet transfer from the forming section into the dryers



Ill.15 Modern Non-woven Felt (ATROCROSS from Heimbach)

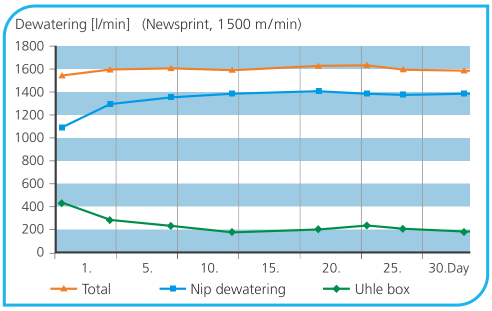
And it also ends when the sheet strength, eg. for reasons of stock composition or basis weight, can no longer withstand the tension.

Conclusion: Only a possible equal control of these influences will permit a continuously secure transfer at a sensible maximum production speed. This does not take account of the quality criteria of the paper.

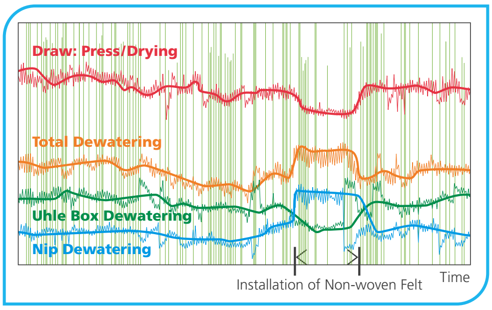
Modern press clothing is designed specially for fast and even dewatering. Experiences from practice show that press felts which dewater preferentially in the nip are particularly suited to meeting the requirements of transfer.
This was achieved, for example, by a non-woven pick-up felt from the ATROCROSS range (Ill.15) shortly after start-up (Newsprint 1500 m/min) with the highest dewatering values almost exclusively via the nip (Ill.16).

The long term trend on another machine showed over several installations of previous felts relatively even curves for draw tension, total dewatering, Uhle box and nip dewatering. By installing a non-woven felt from Heimbach which dewatered primarily in the nip a higher total dewatering was achieved and at the same time the draw tension and the break rate were reduced (Ill.17). The practical results of this installation substantially met the requirements of transfer optimisation.

Primarily developed for the packaging paper industry ATROMAXX.M is the robust and versatile clothing for all packaging paper machines (Ill.18).



Ill.16 Non-woven pick-up felt dewatering



Ill.17 Comparison: Draw tension and dewatering

Ill. 18 Multi-axial Felt (ATROMAXX.M from Heimbach)

These press felts are produced from multi-axial base modules made exclusively from monofilaments. With appropriate adjustment of the batt surfaces they can be suited to every position – from pick-up to 3. press. – and naturally also for shoe-presses. In order to achieve top quality paper surfaces they are also available with the MD batt.

These multi-axial based press felts are proven for maximum dewatering efficiency and life particularly for brown paper grades. Further positive results are already being seen on news and fine paper grades. A further advantage of the monfilament construction is that the base can be supplied with a seam, thus combining the advantages of multi-axial technology with those of conventional seamed felts: ATROMAXX.CONNECT.

ATROMAXX.XF is a combination of woven and diagonal modules combining high dimensional stability with a very fine upper surface layer. Its unique feature is the use of flat monofilaments in the machine direction (Ill.19). The contact surface is increased and a better pressure distribution achieved. The whole base unit provides very high openness combined with maximum structural integrity. Together with the batt surface specially adapted to the precise application an intensive dewatering process occurs with exceptionally fine water removal characteristics on the paper side.

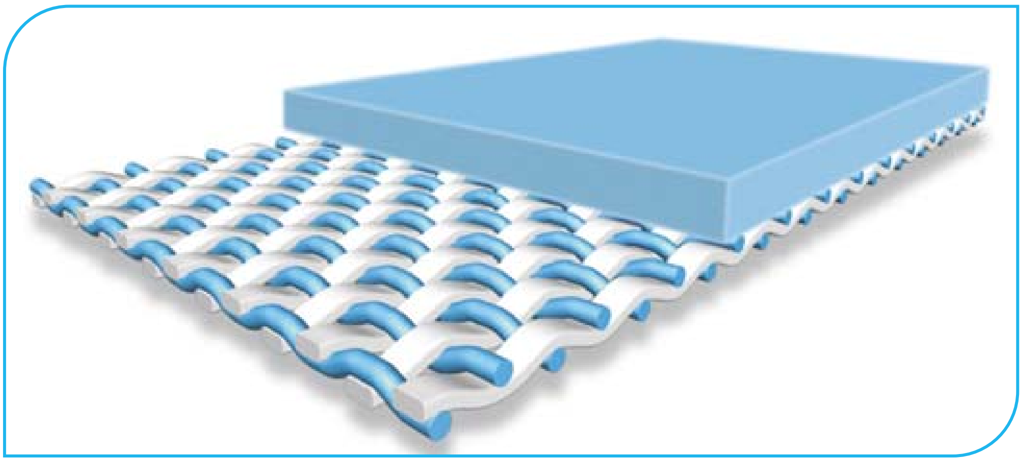
With this performance profile the multiaxial felt fulfils the increased demands for special and fine grades and also for the higher board grades and improved packaging. Batt surfaces of MD batt or flat fibres complete the scope of manufacturing versatility.

The combination of all these characteristics substantially stabilises the sheet transfer. Significantly reduced start-up phases, longer lifes, excellent dry contents, improved paper qualities together with reduced break rates are the factors for optimal runnability.

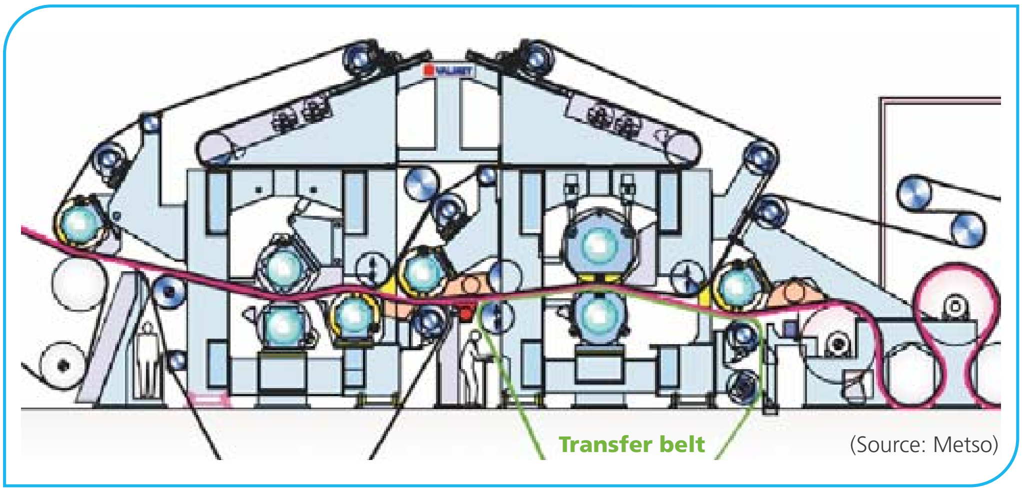
5. Further development

As an example of a machine development in the context of “Optimisation of Sheet Transfer“ a compact, symmetrical 4-felted high speed press section is shown which is designed totally without open draws (Ill.20). With this technology of draw-free sheet control without the specific problems of the central roll speeds of over 2000 m/min can be reached.

In this case with sheet and clothing running together throughout the press section the highest demands are put on the anti-rewetting characteristics of the press felts. A basic feature of this press concept is the clothing of the 2nd bottom position with a transfer belts (Ill.20).



Ill. 19 Base layer paper side



Ill.20 4-felted press section – completely draw-free

In so far as this does not dewater, there is no risk of rewetting. Special sheet-release characteristics of the transfer belt ensure transfer to the dryer section is virtually trouble free.

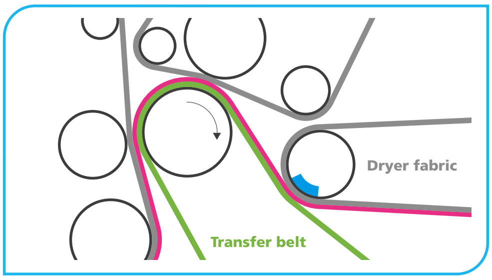
5.1 Influence of transfer belts on sheet transfer

The transfer belt can be described as "transport belt in the conventional sense without dewatering function". Its smooth, even surface with its special topographical features guarantee trouble free sheet transfer, excellent sheet support and problem free sheet separation.

Ill.21 shows the installation of a transfer belt in a Tri-Nip-Press. It wraps the central roll and replaces its hard surface. The paper sheet is dewatered in two nips between the comparatively incompressible belt and the respective press felt. In this way the sheet is completely supported. With the help of the transfer suction roll the separation of the sheet into the dryers takes place without difficulty.

This application example shows the simultaneous fulfilment of important transfer relevant demands.

In general it can be said that the installation of transfer belts provides an ideal solution for the complete closing of open draws and the optimisation of sheet control.



Ill.21 Closing an open draw with a transfer belt

Heimbach specialists would be happy to make their experiences available for your planning and application in transfer optimisation.

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