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ON—MACHINE SURFACE TREATMENT WITH BILLBLADE AND LAS

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Abstract:

Use of four colour printing and high speeds on printing presses put increased demands on paper quality. More and more of the total paper production is coated. Coating methods for simultaneous two side application of coating colour are increasing in use. the coaters are compact, easy to install and demands less manpower than conventional off machine coaters.

The BILLBLADE coater was developed during the 60's. The patented concept is still the same but the design has since then gone through major improvements.

Various BILLBLADE coater configurations are used depending on the type of paper to be produced. C2S papers with 10-12 gsm coating per side can be produced. Up to 16 gsm can be applied at production of C1S. C1S with backside treatment can be produced using the BILLBLADE differential Coater. In many cases, the BILLBLADE coater can be fit in the same space as the size press it replaces, without need for supplemental drying.

The LAS (Liquid Application System) has found its use on weak and highly groundwood containing papers. Coat weights up to 10 g/m^2 can be applied on machine in two separate stations at very low web pressure. The unit can be used both for coating and surface sizing.

General

The demand for coated papers is increasing all over the world. The consumption of coated printing papers in Europe showed an increase of 13%. Coated special paper grades such as functional coatings and technical grades has grown as much as 15%. An investment in an on machine coater like BILLBLADE were both sides are coated in one operation producing 125 tons/day will have a payback of 1-2 years thanks to a higher price of the end product and reduced pulp cost as part of the basis weight is replaced by coating, which has a lower price than imported pulp.

We have found that it is best for a mill new in coating to use an on machine coater. There are two main reasons for this. First, the investment in an on machine coater is about 20 times lower than the investment in an off machine coater. Second, with an on machine coater like BILLBLADE or LAS the mill can produce standard surface sized products. The major part of the time in the beginning and slowly introduce their new coated product and train their personell.

A compact on machine coater is also much easier to operate than a big off machine coater.

The best quality of coated printing papers is obtained with a blade coater. On weak heavy wood containing papers roll coater is, however, recommended because of the lower forces applied to the paper web allowing for a better runnability and less breaks.

BILLBLADE our blade coater is a well established on machine blade coater used at 135 mill on a wide range of papers.

LAS (Liquid Application System) former DAHLGREN coater wich is a roll coater is used for coating of weak webs both by converters and paper industry. Since 1970 more than 400 LAS units have been installed on different web materials.

Intrroduction

The conventional two-roll size press, Figure 1, has for many years been the most common paper machine component for surface treatments ranging from starch to pigmented coating colours, but it has some inherent limitations related to film split and pond turbulence at higher machine speeds.

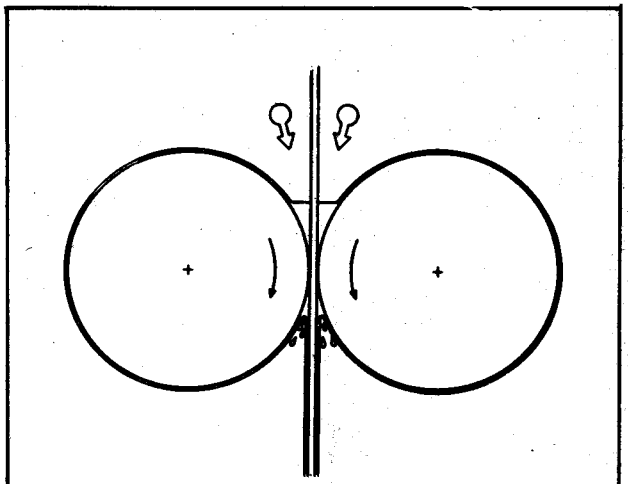

Figure 1. Size press

Film splitting occurs as a result of the two size press rolls running at the same speed; the web tries to follow one of the two roll surfaces. A portion of the coating is lifted away from the sheet, causing an "orange peel" pattern in the coated sheet. This imposes a limit of about 4-5 gsm per side on the amount of pigmented coating which can be sucessfully applied via size press, gate roll or other roll coater. film split also contributes negatively to certain sheet quality characteristics.

As machine speed increases, it is necessary to modify the design of the size press to overcome potential operating problems. the use of larger diameter rolls decreases turbulence. There are machines operating in both North America and Europe with size press rolls up to 1.8 m diameter; with these large roll diameters, it is possible to run at speeds up to 900 m/min. with clear size (starch). The addition or pigment increases the viscosity of the surface size and requires a corresponding decrease in machine speed.

Bilblade Coater

The BILLBLADE Coater was invented in mid 60's as a mean to apply higher coat weights without filmsplit-related problems such as sheet marking. The first commercial BILLBLADE coater was installed in 1967 at Stora Kopparberg, Grycksbo, Sweden, and this coating unit is still producing well-accepted coated printing papers today. since then, the BILLBLADE coater has replace the size press in more than 130 paper machine making coated and/or surface sized papers. the literature includes several descriptions of commercial installations (3-6) and user reports of operating experience (7-8). the principle of the standard BILLBLADE coater is shown in Figure 2.

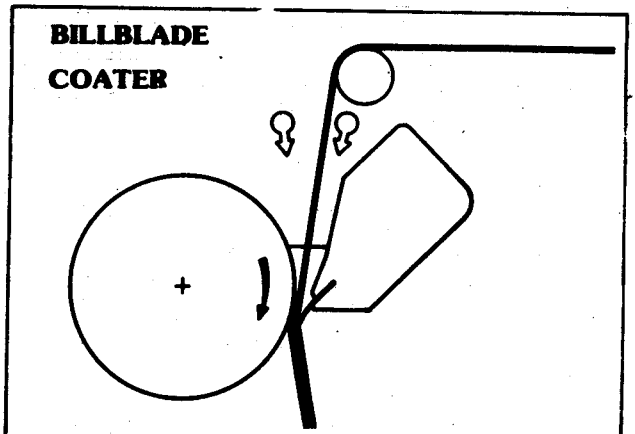

Figure 2. Standard Coater

The paper web runs vertically down through a pond formed between a rotating rubber covered roll and a flexible blade. The thickness of the blade is typically 0.305 mm, exerting a linear pressure of 0.5-2.0 kN/m^2 or a corresponding specific pressure of 500-1500 kN/m^2. With a different blade thickness, extension length, and by adjustment of the blade angle, the blade pressure can be varied within certain limits.

The backing roll is similar to a size press roll, but is has a softer rubber cover (70 P&J) and generally runs 3-5% faster than the speed of the web. this speed differential, combined with a take-off angle of the web away from the roll and toward the blade tip, is the key to achieving an evensided, high quality application on both sides, completely eliminating film split on the roll side. Coat weights of up to 12 gsm/side can be applied without film-splitrelated defects such as 'orange peel' or 'crow's foot'. Coating can be applied at up to 64% solids with viscosities of up to 1,000 cps (Brookfield 100 rpm).

In the case of surface sizing, starch solution concentrations of up to 10-12% solids are suitable even at very high speeds.

Blade Holder

The blade holder is double shelled and completely manufactured in stainless steel, fig. 3. It consists of a heavy inner structure in stainless steel and an outer shell in polished stainless steel plate. To protect the hot starch or coating from influencing the thermal stability of the inner structure and to avoid bending, water is circulated between the two walls. the water cooling also creates a condence film on all outer surfaces which reduces build up of dry coating and cuts downtime for cleaning.

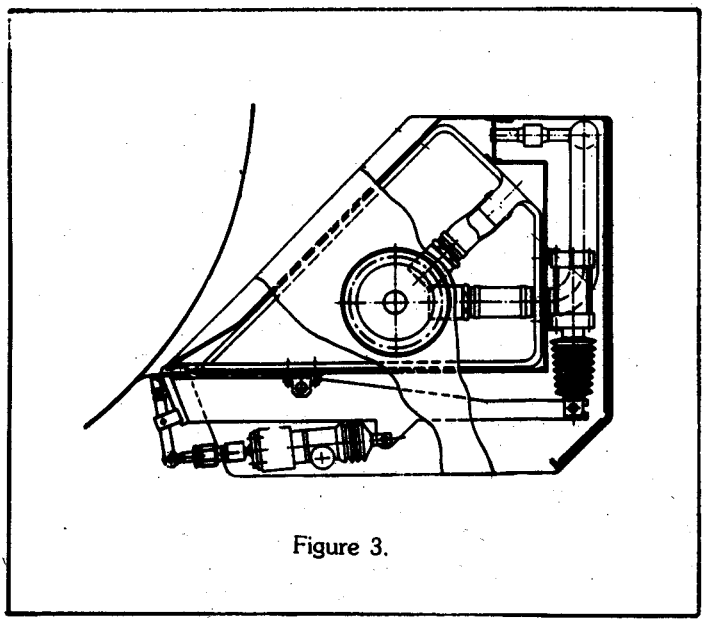

Figure 3.

Coat weight control (CWC) system

The blade holder is equipped with the patented CWC system which allows for coat weight control within a wide range without influencing the blade angle.

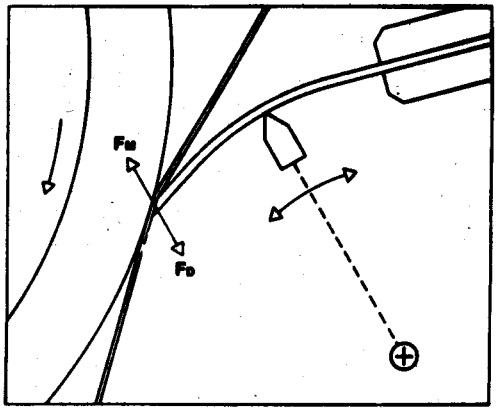

Figure 4. Principle of CWC - System:

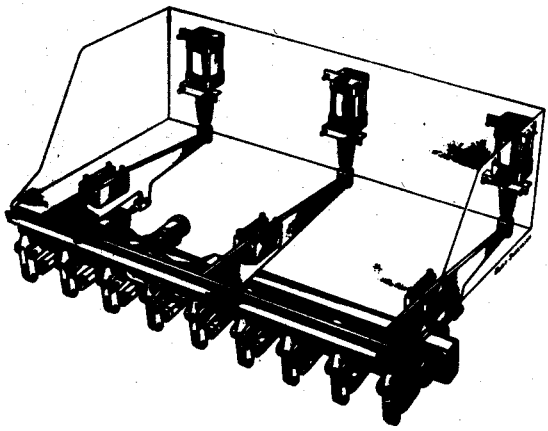

Figure 5 . Blade holder design

The blade is pressed against the web on the backing roll to form a certain arc (bending). The arc of the blade corresponds to the circumference of a circle and the support for the blade is fixed at the centre of this circle. the support will slide along with blade surface **without** changing the position of the blade. the only parameter changed is the blade extension or with other words the stiffness of the blade. Blade angle will stay constant.

The specific pressure can be varied within a wide range by varying the blade extension. Different coat weight levels can be achieved at different blade angles. Blade thickness between 0.3 and 0.5 mm are normally used.

Fig. 5 shows the new blade holder design with CWC-system. the blade is at operation clamped between the fixed top lip and the movable bottom lip. The blade is supported by an adjustable stainless steel bar traverse the machine.

The support bar is fixed through a number of pivoting supports connected to a beam placed below the blade holder. The position of the beam can be varied with an electrical motor connected to the screw jack.

Different free blade lengths can be achieved by moving the beam and the support bar closer or far away from the backing roll. All the pivoting supports are moved in parallel and coat weight will be varied the same amount across the width of the machine.

The design allows for individual control of every pivoting support. this means that the coat weight profile can be varied across the web. Coat weight variations across the web are mostly caused by uneven absorbency in the web which in turn can be caused by different moisture content or different structure of the base paper. the cause of these variations prior to the coater, however, either cannot be corrected or corrected immediately. For example, sometimes the papermaker has to live with an uneven felt for a few days and the possibility to control the profile is of great value. Spacing of the individual pivoting supports, which can be adjusted with a special key allows for profile control every 150 mm of the web.

Blade angle setting

The blade angle can be varied from 5 to 30 degrees without influencing the blade pressure. The blade angle adjustment is used for coarse setting of the coat weight and for adaption of blade geometry to the flow properties of the coating colour. Setting of the blade angle is done by help of an electrical motor and jack screws located inside the frame on the tender side. There is a parallel shaft to the drive side to ensure correct setting at both ends of the blade holder. The blade angle is indicated by a gauge on the framing.

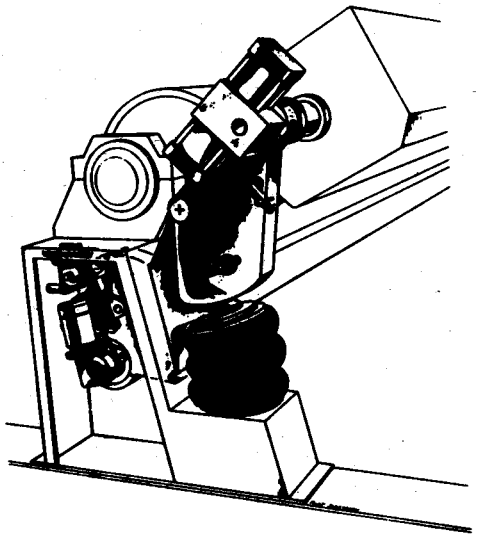

Figure 6. Blade angle setting mechanism

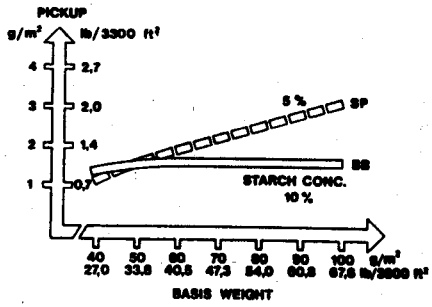

Figure 7. Pickup vs. basis weight for size press and BILLBLADE coater.

Surface Sizing

As shown in figure 7, with a size press, pickup increases as basis weight increases. When surface sizing with BILLBLADE, pickup per unit area remains nearly constant even at higher basis weights. (9).

It is possible to compare the coats of energy for drying a paper surface sized in the BILLBLADE as compared to the size press. the starch pickup in the size press is about 3% which corresponds to a liquid absorption of 500 liters per ton of paper at normal starch concentration. The same pickup is achieved with the BILLBLADE at double starch concentration, i.e. 250 liters less of liquid absorption into the sheet. Generally it requires 1.5-1.8 tons of steam to evaporate 1 ton of water. With a steam cost of $10/ton, this means a savings of $4-5 per ton of paper produced. It is also possible to realize the added value of the incremental tonnage that could be produced on a paper machine that is after-dryer limited.

Effect on Sheet properties

The location of the starch nearer the surface with the BILLBLADE increases its effectiveness in providing sheet surface strength dry pick resistance improves at the same starch pickup. Mills making the switch from size press to BILLBLADE have also reported decreased problems with vessel segment picking when using oak in the furnish.

Figure 10 shows comparitive surface roughness data. Fiber swelling in the size press contributes to surface roughness and a decrease in smoothness. the use of high concentrations and a starch layer close to the surface with BILLBLADE results in reduced surface roughness. In addition, the blade has a smoothing effect in comparision with a size pess roll, which tends to pick fibers from the surface.

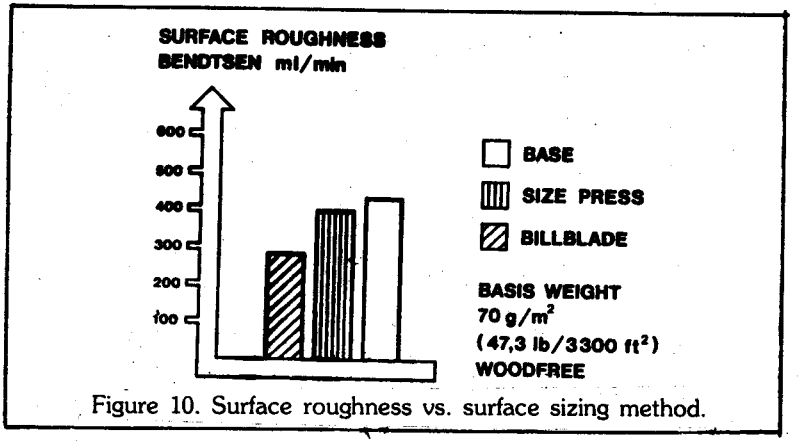

Figure 10. Surface roughness vs. surface sizing method.

The high concentration of the starch solution also influence porosity as shown in Figure 11. the blade application provides better film forming and thus reduces porosity. Less refining horse power is needed to reach a given porosity value when using BILLBLADE. There is also less risk for strikethrough from a following top coat when producing paper for blade coating.

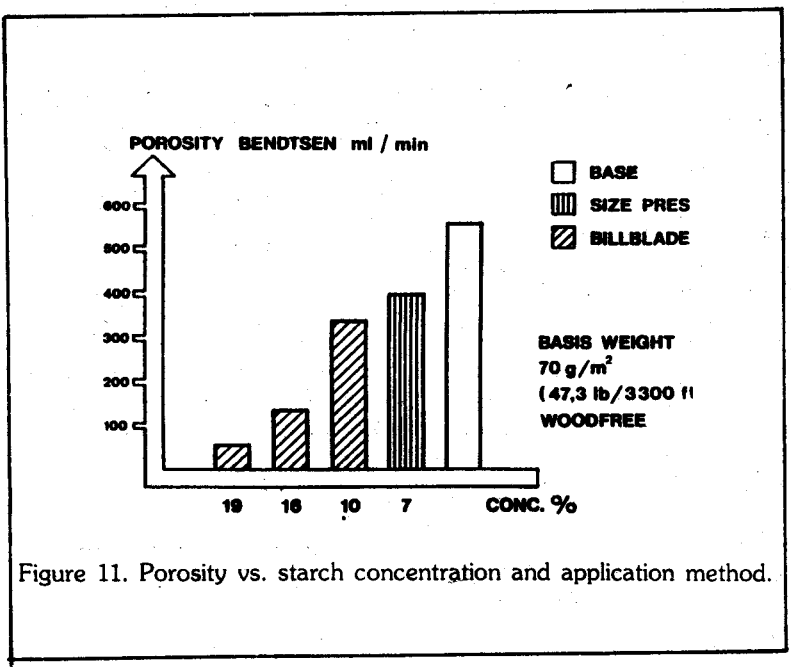

Figure 11. Porosity vs. starch concentration and application method.

The orientation of the starch closer to the surface with improved closing of the sheet results in better ink holdout, higher ink gloss, and better solvent holdout. Figure 12 shows the resulting improvement in print quality.

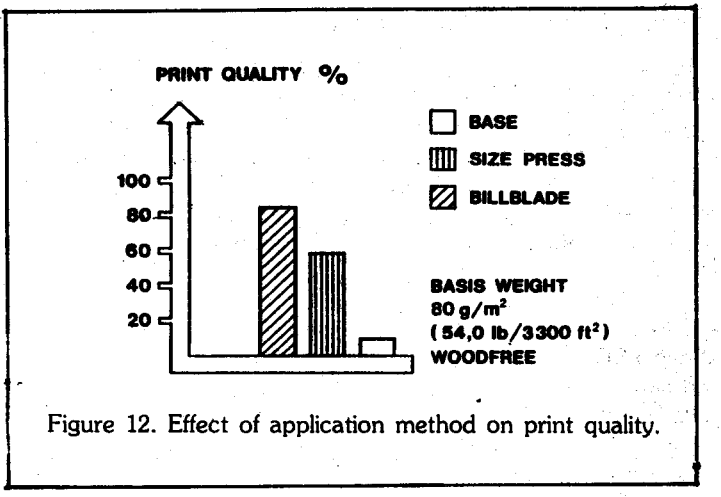

Figure 12. Effect of application method on print quality.

Lint on the rubber blanket of the offset pess is one of the major problems of using uncoated offset paper. Surface sizing with BILLBLADE reduces linting by providing better bonding of loose fibers into the surface. As shown in figure 13, printing trials have shown nearly a 50% reduction in linting by switching to BILLBLADE surface sizing.

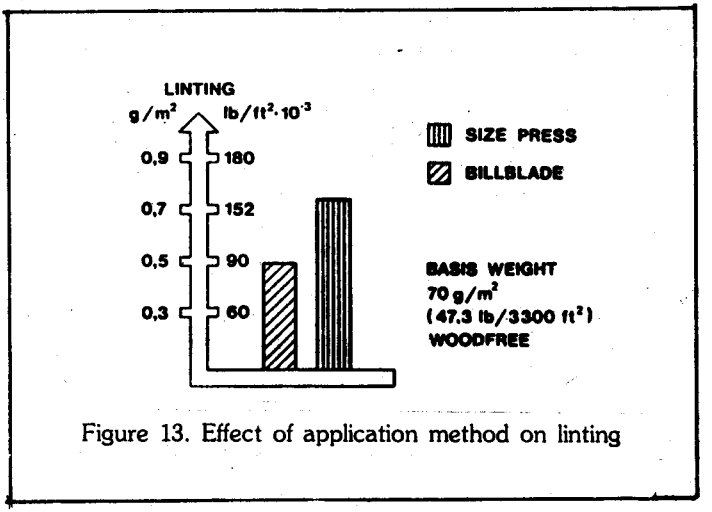

Figure 13. Effect of application method on linting

The lack of penetration of starch into the sheet with BILLBLADE means that internal bond improvement cannot be obtained via BILLBLADE surface sizing. It may be necessary to add 0.3 to 1.0% cationic starch at the wet end to get sufficient internal bond. There may also be a need to make grades where it is necessary to saturate the sheet; these grades cannot be made via the BILLBLADE process. If a machine is to make both surface-sized and saturated grades, consideration should be given to installation of a BILLBLADE COMBI COATER, which can be run as either a BILLBLADE or a size press; this equipment will be discussed in more detail later in this paper.

Coating

When a BILLBLADE coater replaces a size press for the production of coated paper, a complete new range of grades can be made. C25 papers with 10-12 gsm of coating per side can be made and up to 16 gsm can be applied CIS. Coating colors with solids of 56-64% and viscosities up to 1000 cps (Brookfiels 100 rpm) can be used. Both matte finish grades using 100% calcium carbonate colors, and high gloss papers are produced with BILLBLADE on-machine coaters in the speed range of 150-600 m/min.

The most significant differences between size press and BILLBLADE coated papers can be seen on fiber coverage and ink absorption. Both of these quality parameters improve substantially.

Big differences in smoothness have also been observed because of the absence of a film split pattern on the surface of the BILLBLADE coated sheet. Improvements in runnability in sheet fed printing presses have been noted primarily due to increased stiffness and bulk.

BILLBLADE Configurations

There are various configurations of the BILLBLADE coater; the choice of configuration and the installation layout are dependent on the types of paper to be made.

Figure 14 shows the BILLBLADE Standard Coater, which consists of the blade holder, a backing roll and a lead-in roll with motorized adjustable support. It is shown in the C2S coating/surface sizing position, with the sheet going vertically downward through ponds on both sides. This configuration will provide even pickup on both sides of the sheets, with coat weights ranging from 0 (water application) to 12 gsm per side.

By moving the lead-in roll over to wrap the backing roll (the roll-side supply header is also removed), the BILLBLADE Standard Coater becomes a CIS pond coater which can apply 0 to 16 gsm.

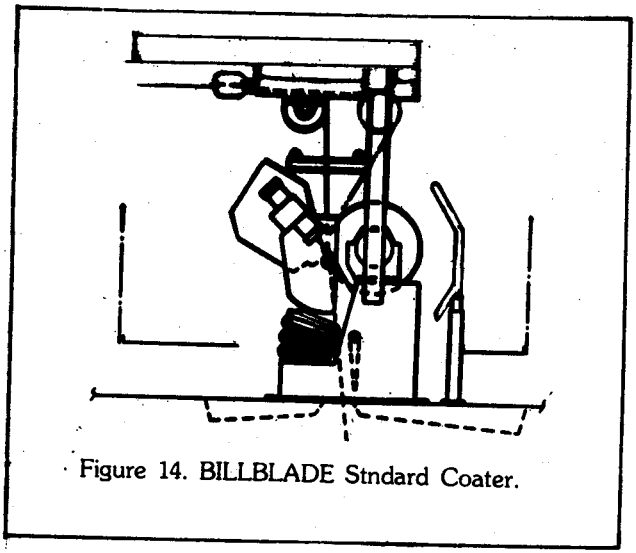

Figure 14. BILLBLADE Stndard Coater.

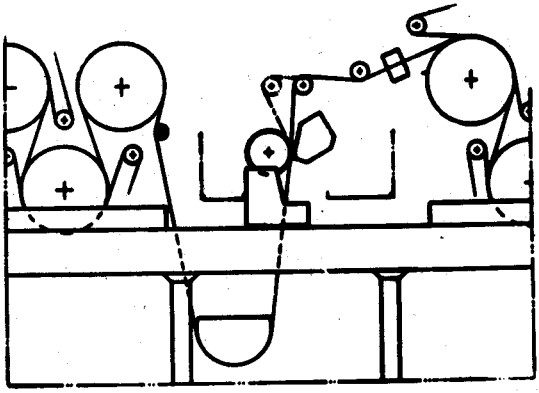

Figure 15. BILLBLADE Standard Coater layout for application of maximum coat weights.

The backing roll is oversped and does not drive the sheet; rather, the sheet is pulled through the BILLBLADE by the following dryer section. to avoid damage to the coated surface, the sheet is turned into the after-dryer section by an air turn segment. The segment is equipped with a load cell to measure sheet tension; this sheet tension signal is used to control the speed of the after-dryer section. An infra drier is normally installed prior to or after the segment to avoid build up on the first drying cylinder.

A chill roll is used for web turning on high speed sizing units. Up to 2 gsm/side at 900 m/min requires only a short draw to the chilled roll as shown in figure 16. This installation has been running successfully on the U.S. West Coast since 1982.

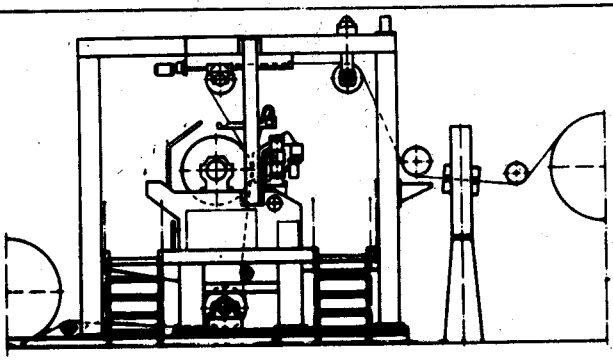

Figure 16. BILLBLADE high speed surface sizing installation at U.S. West Coast mill

As noted above, the BILLBLADE Standard Coater can coat C2S or C1S. However, in most cases, one BILLBLADE is installed to replace one size press, and production of C1S paper without a backside treatment causes curl problems. the BILLBLADE Differential Coater, as shown in Figure 17, was developed to overcome this problem. the BILLBLADE Differential Coater consists of a blade holder, a backing roll, stainless steel metering roll, and a soft rubber (110 P&J) metering roll. This configuration was developed originally to allow simultaneous backside starch application (curl coat) for C1S label papers. It was quickly adopted for the production of carbonless papers and today is considered state-of-the art for on-machine CF production worldwide. It is also widely used for the production of specialty and technical papers such as security base, tape base and various barrier-coated grades.

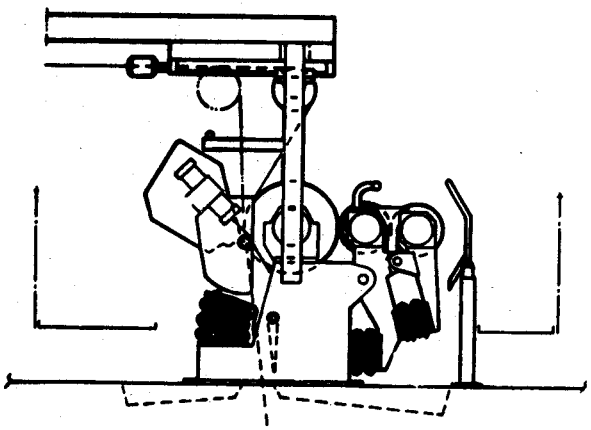

Figure 17. BILLBLADE Differential coater

The metering roll chain on the BILLBLADE Differential Coater looks like half a gate roll coater, but there are some important differences. All of the rolls are cylindrical rather than crowned; this leads to longer roll life and fewer mechanical problems. A micro-gap is maintained between the outside (soft) metering roll and the center (stainless steel) roll, and he chrome roll is run at kiss pressure against the backing roll. the flexible blade provides uniform coating distribution but does not cause heat buildup or requirement for crowning of the backing roll. Varying the micro-gap setting and metering roll speeds controls the amount of backside coating applied. Coat weights on the blade side can be up to 16 gsm. Because the sheet wraps the backing roll, it is not practical to put on more than 3-4 gsm on the roll side; the metering rolls are capable of applying higher coat weights, but a roll pattern mark is likely to occur because of the Differential Coater is, of course, capable of being run as a Standard Coater by simply unloading the metering rolls. the installation layout for the Differential coater requires some additional room in the machine direction for the metering rolls. the criteria for length of draw to the first chilled roll are the same as for the Standard Coater. In cases where only C1S grades are to be made, it is common to use one chilled roll and center on a bottom after-dryer, since the first contact with the coated side is the second after-dryer cylinder.

As noted above, there are cases in which both deep penetrated and surface-sized/coated grades are to be made on the same machine. the BILLBLADE Combi Coater, shown in Figure 18, was developed to meet this need. the BILLBLADE Combi Coater consists of one blade holder, a (40-45 P&J) backing roll which also serves as the size press soft roll, and a (0 P&J) size press hard roll. The backing roll is equipped with a reversible drive. Switching between size press and BILLBLADE modes can be done quickly and conveniently; it requires reversing the drive, changing position of a feed pipe, and splicing a rope.

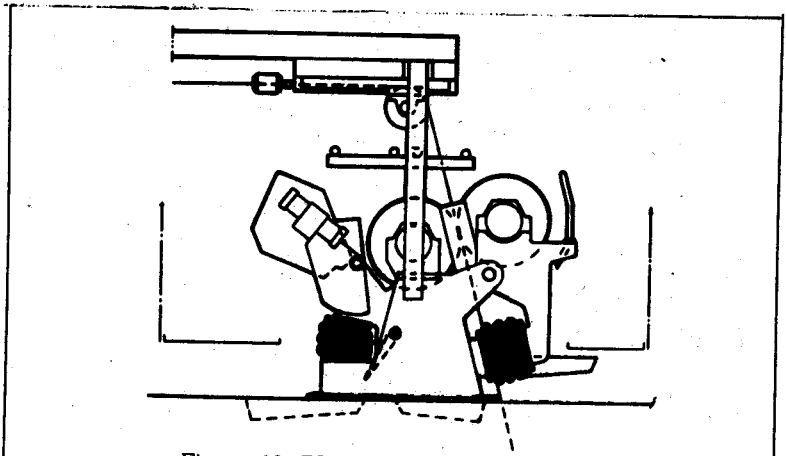

Figure 18. BILLBLADE Combi Coater

Figure 19 shows the layout of a European BILLBLADE Combi Coater high speed or coating and surface sizing.

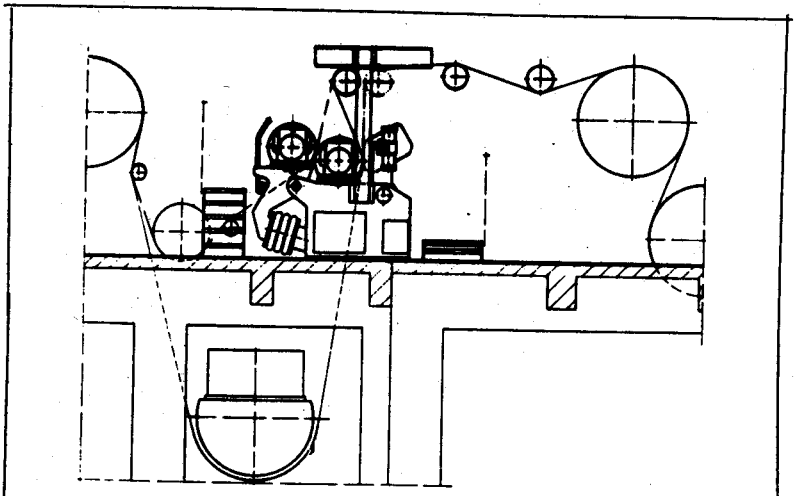

Figure 19. BILLBLADE Combi Coater Installation

The BILLBLADE Differential Combi Coater was developed for mills needing to run a wide variety of specialties on a single machine. In this case, the (O P&J) size press hard roll also serves as the center metering roll, and it also must have a reversible drive.

Figure 20 shows the layout of the BILLBLADE Differential Combi Coater at an Estern European mill which makes grades ranging from lightweight coated papers to heavyweight boards, including a large variety of technical and packaging specialities.

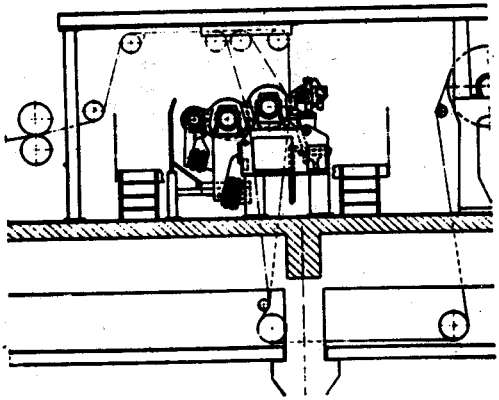

FIGURE 20. BILLBLADE Differential Combi Coater layout at Eastern European mill making Wide range of grades.

One of the primary design criteria of the BILLBLADE coater is that it not require a separate coater operator. the 'coater-on' sequence is fully automated. In the case of a break, the feed system and backing roll are automatically washed.

The recommended recirculation rate for the BILLBLADE is 10:1. A pressure filter is recommended in the supply line to the coater. Both slotted and bag type filters are being used successfully in various mills. In cases where the base sheet has a lot of loose fibers on the surface, it is advisable to install a coarse screen on the coating return line.

The fluid layer behind the sheet results in fewer grit streaks or blade scratches than are seen with a typical stiff blade. The fluid layer also plays a large part in reducing web breaks due to holes. Users report that the number of breaks at the BILLBLADE is slightly higher than with a god size press but much lower than with a conventional blade. (8).

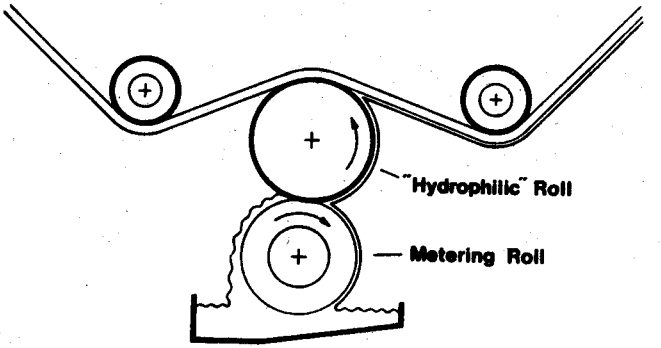

Fig. 21- LAS principle of operation

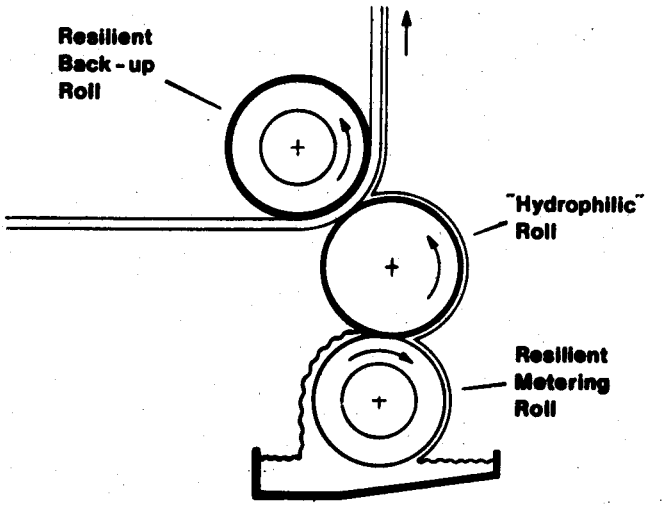

FIGURE 22 - LAS three roll configurations

In many cases, a BILLBLADE coater can be installed in the space previously occupied by the size press it replaces. In some cases, it may be necessary to remove one or two dryers. It is common practice to Teflon coat or provide another type of anti-stick surface on the first 1 or 2 after-dryers, particularly when maximum coat withts are to be applied. Because the BILLBLADE operates at higher solids than the size press, the existing after-dryer section usually is adequate, even when machine speeds and/or coat weights are to be increased.

Liquid Application System (LAS):

The Liquid Application System (LAS) is a versatile hydrophilic roll coater which allows the papermaker or converter to apply accurately controlled amounts of wide varieties of liquids to paper, paperboard or other moving webs. Application rate and degree of penetration into the web can be controlled precisely and independently. Materials applied can range from water to pigmented and/or functional coatings. the LAS causes only minimal stress on the sheet and provides excellent runnability even on lightweight, weak sheets. It has numerous applications both on-machine and in off-machine coating/converting lines.

Principle of operation:

The heart of the LAS is a patented hydrophilic transfer roll (Fig. 19). this roll is chromiunm plated and passivated by a proprietary etching process. the treated roll can carry wet films 3-15 microns thick with out slinging or spattering-even at speeds up to 2000 m/min.

Liquid is supplied to the transfer roll by a soft rubber covered (30-35^0 Shore A) metering roll running in a supply pan. Varying the speed of the metering roll maintains a flooded nip with coatings of differing viscosities to prevent air incursion into the coating colour. Pressure in the metering/transfer roll nip is controlled to provide an uniform, unbroken film on the transfer roll.

Both the metering roll and the transfer roll are cylindrical rather than crowned. Compensation for rolldeflection is achieved by a patented skewing mechanism. "Skewing" or rotating the axis of the metering roll on one end in relation to the transfer roll progressively increases the pressure at the centre of the nip without changing pressures on the ends. To provide cross direction coat weight control, each end of the metering roll is equipped with a pressure control. Combinations of skew and end pressure controls can provide any desired profile of film thickness to the transfer roll.

When the LAS is run as a roll coater, the transfer roll is run in the same direction as the web to apply the liquid film to the web. A speed differential is maintained between web speed and transfer roll speed to smooth the coating and minimize film split pattern on the coated sheet.

The transfer roll may be run in the reverse direction to achieve high coat weights or impregnate the substrate.

The LAS is designed in either a two-roll or three-roll configuration (Fig. 22) to suit the type of applications, characteristics of the liquid being applied, and properties of the web being treated.

Starches of 2 10% solutions concentration and other low viscosity materials may be applied to the web surface by the two-roll LAS. However, with a two-roll system, penetration is partially dependent on viscosity and solids content. For application of a wider variety or materials and more precise control of penetration, the three-roll LAS is preferable.

Three Roll LAS Coater/Sizer

When pigmented and/or functional coatings are to be applied, a resilient rubber covered (48-52° Shore A) backing roll is used to assure uniform intimate contact of the sheet with the transfer roll controls coat weight and/or impregnation. With the transfer roll running in the same direction as the web, transfer roll speed is used to fine tune the coat weight. Speed differential and nip pressure between the backing and transfer rolls are varied to control depth of penetration into the web. the backing roll speed must be matched to web speed; this is normally done by interfacing the backing roll drive with the paper machine or processing line drive system. Independent drive controls are used for the metering and transfer rolls.

Paper Mill Applications

The LAS may be used either on or off machine to apply starch, pigmented pre-coatings or coatings, and functional coatings. Since the LAS does not apply significant stress to the sheet, it provides excellent runnability on lightweight, groundwood, waterleaf and other weak sheets. It will pass holes, edge cracks and other sheet defects without breaks.

When surface sizing with the LAS, it is possible to run much higher starch concentrations than with a conventional size press. In most cases less starch is required to achieve the desired surface strength. Starch application rate can be controlled independently from solution concentration. Degree of starch penetration can be controlled to minimize objectionable losses in internal bond.

The LAS applies a uniform film of starch and is not affected by an uneven incoming moisture profile. this eliminates the need to overdry the sheet in main dryer section to flatten the profile- thus reducing energy requirement and allowing higher machine speeds.

The space required for two LAS units installed in tandem is about the same as for a conventional size press (Fig. 22). In most cases, no supplementary drying is required. On some very high speed machines, it is desireable to install an infra-red heater in the sheet run between the two LAS units.

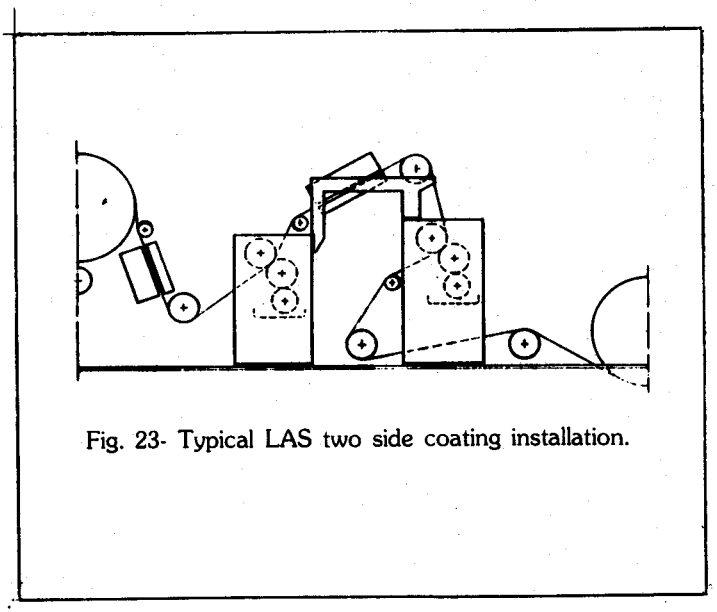

Fig. 23- Typical LAS two side coating installation.

One of the rapidly growing applications of the LAS coater is in surface treatment of newsprint. In this application, starch is applied at about 15% solids to produce lint-free offset newsprint. the same LAS units are also used to apply about 3 to 5 g/m^2 of pigmented coating per side at about 40% solids to produce a relatively inexpensive sheet suitable for four-colour heatset offset printing. when combined with soft-nip calendering, the LAS treated heatset offset paper approaches the performance of LWC papers at a poduction cost which is far below.

Two roll LAS Moisturizer/Decurler

In applications such as moisturizing or decurling, where the material being applied is water or a low viscosity solution, a two-roll LAS configuration is usually adeuqate. Adjustable web carrying rolls are installed before and after the LAS to obtain the desired amount of wrap on the transfer roll. In the two-roll configurations, the speed of the LAS is controlled independently from machine or line speed.

The LAS Moisturizer/Decurler is suitble for any web speed up to 2000 m/min. Moisture addition can be controlled to close tolerances.

The amount of water that can be applied is dependent on the style of LAS being used and the properties of the web. Up to 10% water may be added to an open structured uncoated paper. the water penetrated the sheet immediately, leaving no surface water, thus making it possible to run directly onto the reel or into other in line processes such as laminating or coating. On a coated or other high barrier sheet water addition may be limited to about 3%. Typical applications include on-machine correction of overdryed edges and moisturizing ahead of a gloss calender.

Curl causes problems not only in converting of paper and paper board but also in end use of converted products. Papermakers have tried various measures to control curl, including differential top/bottom drying, water sprays, back wetting, and backside starch addition. Most of these methods provide only temporary improvement, with curl reoccuring during converting or end use in response to change in ambient humidity.

The LAS decurls by controlled impregnation of water throughout the sheet, relaxing the stresses caused by drying on the paper machine or coater. The sheet is brought to its ambient, stade, uniform moisture content and will remain flat in varying humidity conditions. Typical applications of LAS decurling include carbonelss, themographic, MG, label, envelope, silicone coated papers and coated-one-side paper and board.