A New Look on Paper Machine Pressing and Forming Fabrics.

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ABSTRACT

The Paper reviews the current status and developments in Forming fabrics, Press fabrics and Shoe Press fabrics.

INTRODUCTION

Today there is a great deal of pressure on the requirements demand of Paper Machine Fabrics (PMF), because of great importance to achieve the highest possible efficiency and productivity from every paper machine, regardless of paper grade or size or age of the machine.

Most of the world's paper machines have been well settled on their foundations for years and paper machine fabric manufacturers say that most of their new fabric designs are intended for these established paper machines. However, paper mills with older machines should remain alert to new fabric designs for both paper sheet quality advantages they may bring and because of their potentially longer life.

The significance of paper machine fabric is the major influence it has on the quality of paper and the efficiency of the production process. Every PMF manufacturing group or company make their own individual contribution to paper quality and machine runnability. Every detail on a paper machine must perform to planned expectations in order to achieve efficiency requirements in the modern process and for this importance PMF manufacturers trying to work in direct partnership with paper mills in order to design the best fabric for their particular and definite requirements.

THE CHALLENGES

A lot of affort goes into making paper machine fabrics fit for their purpose. The tolerance demanded of today's PMF are incrediably punishing, and ofcourse for good reasons.

Taking the long view, the challenges facing the PMF industry are very clear - the materials have to get stronger, the weaves have to give better uniformity, the yarn designs must allow for enhanced dewatering characteristics while picking of less dirt and stickies and this all has to be achieved at less cost.

Improved paper products, faster production speeds, reduced water consumption and furnishes that contain a greater recycled fibre and filler content set PMF suppliers new challenges.

Formers are becoming wider and have shorter fabric and felt run lengths. These place additional demands on the dimentional stability of the PMF to prevent vibration problems.

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Most of the PMF experts recommend a complete analysis of the capability of older machines to determine the feasibility of their producing certain grades profitably, "For example" it is of great importance to use "Machine Economic Analysis" which analyses the machine from the stock flow approach to the reel and includes recommendations for improving sheet quality and machine performance through changes in operating procedures, maintenance, fabric designs and capital modifications.

The objective also to clothe the machine according to the interrelated characteristics of its fibre source and pulping system, forming configuration, press arrangement and pressures and its drying section's configuration with its particular steam pressures and steam quality.

A SHORT REVIEW ON FAST FORMING FABRICS

Improvements in formation, profile, smoothness, porosity, two- sidedness, strength properties, bulk and filler distribution are essential requirements, when there is demand for volume production and higher profitability and to meet these demands, significant capital investment in the latest equipments and machineries has been necessary. This is examplified by the latest design of former, roll, press with much higher design speeds on the paper machine and to produce more complex designs of forming fabric, it is required to have the new high-speed looms and automatic joining machines by the PMF manufacturer.

There has been a transition from relatively simple single layer to the double layer structures and then to the extremely complex and demanding to produce triplex designs that are available today. Changes seen over the last decade have included the reduction in paper side yarn diameters, an increase in machine side yarn diameters, reduction in yarn stiffness to cope with the more complex structures, lower permeability and increasing meshes.

A precursor to introducing new designs concepts is to ensure that the forming fabric meets the basic requirements. From this base features can be added which are focussed on the specific requirements of the end user.

THE FABRIC FUNDAMENTALLY MUST

Be an effective transmitter or conveyor belt:- It is essential that the fabric is physically able to transmit the drive load and withstand tension variations around the loop without excessive stretching, narrowing or wrinkling, so that the paper is formed and conveyed uniformly to the pickup.

Give an economic life:- The fabric must run for an economic period before its performance become unacceptably effected as a result of wear.

Be an effective filter:- The filtering properties of the fabric are essential to many factors, including sheet quality, dryness at the pickup and fines/filler retention.

General characteristics of today's high speed forming sections place increasing demands on fabric design and include:

Short dwell time in forming with high vaccum zones.

High drainage forces and pressures.

First determination of sheet properties.

High fabric tensions.

To produce new designs that can meet the basic requirements and add value, many criteria have to be taken into account. In future the temperature of the stock will play an increasingly important role. At present the mill works at 45° to 50°C and is possible in future to 60° to 70°C. In forming, the load on the fabric varies considerably during each rotation in the path of the fabric. Vaccum levels vary and there is a constant draw on the fabric - putting the material making up the fabric under constant mechanical stress.

The introduction of the double layer fabric increased the forming fabrics average life and the next generation was the triple layer fabric which was a revolution in its time. At present, most PMF manufacturers have been developing triplex designs, is nothing new with the first attempts seen in 1970's although it did not start to emerge significantly until the mid 80's. Triplex was a dream for paper makers, a plain weave top layer giving the potential for optimum paper making properties and multi-shaft bottom layer for weave resistance. These two layers were stiched together to form a stable structure for good runnability. Continuous developments in Triplex construction have minimised problems such as marking, internal wear and instability. The changes included altering the relationship between the MD &

CMD mesh counts and yarn diameters in order to improve stability and reduce caliper. There has always been a compromise while designing the fabric.

The PMF manufacturer always introducing new design products that incorporate new concept, adding value to fabric life and performance. The consumption of forming fabirc is growing much more slowly than the consumption of paper showing that the life of the fabric is constantly being extended. Some years ago it was calculated that the consumption of fabric was about $20m^2$ per 1000 tonnes of paper produced. This is now reduced to $13.15m^2$ per 1000 tonnes of paper.

PRESS FABRICS, FASHIONING TO NEW DESIGNS

A press fabric has to be designed to provide the appropriate void volume in the nip, improve sheet finish and run trouble free for a given period. While different designs are being used to meet the requirements of each individual machine and position. Laminated designs are required and preferred in most cases. Laminated fabrics are made mainly of two individual base fabrics. The bottom base, which can be a single or a double layer, provides the necessary void volume to handle the water expressed from the sheet in to the nip. The number of layers in the bottom base is determined by the amount of water to be handled in the nip, the press loading (and the belt type in case of shoe press). The top base, which is considerably finer than the bottom base, assures an even pressure distribution in the nip. The top base in a laminated press fabric is a key element in optimising the pressure uniformity improving sheet smoothness and minimising sheet twosidedness. It is from experience that the yarn diameter used in both CD and MD and the number of yarn per decimeter have a significant impact on the pressure uniformity. Superfine top bases are similar in nature to the forming fabrics as they use single monofilament in both CD and MD with a very high numbers of yarns per decimeter in MD. Topography measurements have also shown that a laminated fabric utilising a superfine top base generally gets smoother when running on a paper machine, while some other laminates with coarser top bases can get rougher.

Smoothness is also influenced by the type of surface fibre used. Decreasing the fibre diameter generally improves the uniformity and increases sheet smoothness. The batt mass uniformity, needle type and finishing procedures used in the manufacturing of a press fabric, influence fabric uniformity. Batt fibre fineness and the manufacturing processes have to be carefully selected to optimise the pressure uniformity without sacrificing water removal, fabric wear and filling. Fibres that are too fine can lead to water removal problems, premature filling or wear and higher sensitivity to wad burn problems.

Heavy compaction will make a felt denser so that it will saturate more quickly. The pre-compaction also decreases initial air permeability of the new fabric and thus the felt will startup faster than without precompaction. To prevent compaction press fabric should have a base which is compressible in a way that gives a maximum water removal rate in the nip while at the same time having the ability to regain its original form and thickness as quickly as possible after the nip. It is important not to have too much batt on the top of the base fabric to prevent base fabric marking.

To prevent plugging it is also important not to have too much batt on the fabric as impurities tend to adhere more easily to the batt layers than the base fabric.

Of late, replacing the normal non-stabilised yarn with 100% stabilised yarn and using high viscosity fibres, which have higher strength properties, better heat resistance and a much greater resistance to chemicals, in the press fabric design has shown the fabric for better resistance to wear over the uhle box and in the press nip. Use of these high viscosity fibres ensure that there is no need to change felts early due to excessive wear.

Product developments have concentrated on the engineering of the press fabric. One new design, in which a standard woven base cloth combines with a new non-woven membranc of polymer. This provides better sheet support on the felt surface leading to uniform pressure distribution and a flatter sheet profile. The product's resilience helps increase its capacity to absorb energy in the nip, reducing roll vibration and extending operating life.

A new concept is the Seam Tech Press Fabric which greatly enhances the ease with which a felt can be replaced. The new improved seaming technique makes it possible to run the Seam Tech press Fabric on high speed wider newsprint and fine paper machines.

The ability to supply a Seamed press fabric improves safety factors on the PM while replacement

takes place easily. It also possible to make a stiffer fabric that would make the replacement of an endless press fabric almost impossible. It means that paper machine does not have to be opened, reducing the down-time necessary for a press fabric change. Down-time, usually calculated at 6-8 hours, has been reduced to 1-2 hours.

SHOE PRESS FABRIC

Increasing paper machine speeds, demands on paper machine efficiency and paper quality in printing and writing grades has brought about increased performance requirements for the press section technology. The demands have been met by the use of Shoe Presses placed after a roll press unit or in series. Most shoe presses are used on the third nip but there are also several machines using them on the first, second, or fourth nip. The machines are becoming more sophisticated with multiple single felted and double felted shoe presses, and transfer felts being used between the third and fourth presses.

Shoe pressing substantially increase the sheet dryness in a press section at reduced peak pressures. Paper machines have been able to achieve up to 52% solids after the press section and so far speeds up to 1670 m/min have been obtained on a newsprint machine. The increase in dryness can be explained by the high press impulse obtained with a shoe press. The press impulse (nip load/nip width) X (nip width/ machine speed) is about 4-7 times higher with a shoe press compared to a roll press. The nip width of a roll press varies between 20 and 50 mm, while most shoe presses have a nip width of 250 mm.

A shoe press fabric is similar to a roll press in that the press fabric has to be engineered to meet the requirements of each individual machine and position. Some of these factors, such as the speed furnish, grades, and weights, are equally important on both type of presses. However, the shoe press brings other variables that are of the utmost importance. The location of the shoe, the water available in the sheet before the nip, press loading, shoe width, and tilt as well as the type of belts used can all impact the press fabric design.

Shoe presses will create some special requirements for the press fabric, both from runnability and felt life points of view. The most important requirement for the fabric is to provide good and constant water removal during the life of the fabric, making it possible to achieve high levels of dryness in the sheet immediately after the press section. For consistent runnability of the shoe press it is essential that the press fabric should have good resistance to compacting and wear. Shoe presses will also create special requirements from the surface of the press fabric affecting the quality of the paper. It is important to have a non-marking base fabric and fine enough fibres on the surface of the felt combined with good wear resistance. In the shoe press wear problem can occur because of the long dwell time in the nip and the friction which is created by the long nip at high pressure. From the paper quality point of view it is important to achieve the required bulk and smoothness without the problems of two-sidedness.

Regarding water removal in the shoe presses the two most important felt properties are high enough void volume to be able to carry water away from the nip and high enough water permeability in the Z direction. This is in order that the water can first be removed from the paper web in to the felt, while in the nip, and then be removed from the felt into the uhle box. Good water permeability in both CD and MD parameters are also important in shoe press fabric, particularly where grooved belts are used. if the belt has open areas it is possible to remove water actually in the nip itself but this means that the water must be able to travel laterally in the CD direction within the felt. A grooved belt also reduces the hydraulic pressure in the nip, minimises re-wetting, and can contribute to improved sheet finish. Agrooved belt allows a lower void volume press fabric to be used. This provides a better equalisation of the dewatering ratio between the nip and the uhle box.

The reduced flow rate in a shoe press and the long nip residence time help to accentuate the sheet smoothness difference between the felt and the roll side in a shoe press. All the shoe press fabric in every position have a laminated base weave structure and the technical aspects of shoe press fabrics are very critical. As already explained earlier, the laminated structure gives better performance to felts such as longer working life, higher water removal capacity and better runnability. The top base in the laminated press fabric optimize even pressure distribution, better sheet smoothness and help minimising sheet two-sidedness. The bottom base, which is the load bearing member on the machine, has to be very stable in MD to conform to the difference in tension between the in-going and out-going side of the shoe.