Developments in machine clothings

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During the process of paper making, a large amount of water is added and removed before paper is being made. Water removal in the paper machine is done by mechanical means up to the press section and by thermal evaporation in the dryer zone.

It is well known that the cost of water removal in the press section is significantly less than in the dryer section. Traditionally, it has been five times as expensive to remove water in the dryer section as in the press section, with todays higher fuel costs, it is probably closer to 20 times as expensive.

Another way of looking at this is that for each percentage point increase in dryness out of the press section means an approximate 4% reduction in the amount of water removal required in the dryer section. This means these will be an approximate 4% savings in steam or a 4% increase in drying capacity on dryer limited machines.

This economics, has brought a very rapid developments in the design of press part and simultaneously in the press clothings. To further economize the situation, dryer clothings are developed from cotton-synthetic or needled dryer felts of low permeability to open-mesh fabrics to mono-filament contained screens of high permeability.

No one will deny, for instance, that escalating costs of capital equipments, combined with ever increasing operating costs, are placing tremendous pressures on today's paper maker to squeeze additional tonnage from existing machines while at the same time reducing operating costs. Two main keys to increased profitability are machines productivity and energy reduction objeetives, which can be achieved by proper three sections of the paper machine.

DEVELOPMENTS OF PRESSES

In the last few years, paper machine press sections have been transformed to a large extent. The changes have been brought about by the advent of new types of presses based on the concept of "vertical" flow. The path of water travel is greatly reduced in vertical flow presses, that has lead to many innovations in press part designs from plain presses and other high intensity Nip presses like grooved presses, stainless steel presses, extended nip presses, blind drilled presses etc.

To understand why vertical flow presses have gained importance, it is necessary to look at what happens in a Nip. As sheet and felt enter a plain press nip, the imposed roll load, causes them to be progressively compressed. At mid-nip they reach their minimum thickness. At the beginning of the nip, little water removal occurs, But as pressing continues, water from the sheet begins to fill the void spaces in the felt. At some point, the felt becomes saturated. Hydraulic pressure begins to increase aad force water out of the felt. In plain presses if load is increased above a relatively low value, hydraulic pressure buildup occurs more rcpidly than it can be related by out flow of water.

The resultant back pressure disrupts the sheet and crushing results.

In suction press the distance that expressed water must travel to reach a hole in the roll is short compared to the distance in a plain press. However, because of their shell construction, the distance betwen the holes cannot be made very short, otherwise roll becomes weak. Pressure distribution between hole and land area becomes uneven in suction press and hence unless the felt equalises this difference shadow marking may result.

One of the first presses designed to improve this situation was the fabric press. The fabric under the felt provides void volum to receive water in the nip and flow distance is greatly reduced.

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Other vertical flow presses like shrink sleeve, grooved press, blind roll etc. embody this same idea i.e. to provide water receptacle in the nip.

The other approaches getting popularity are the installation of couch press, double felting and split top Board macine felt, and. extended nip presses development by Beloit Corpn.

Couch Press

The term 'Couch Press' describes an inverted felt run positioned at the couch roll in the forming section. The concept is based on the principle that double-sided dewatering of a pulp or paper web will yield higher sheet dry ness and better quality than normal singlesided de-watering. This arrangement allows for higher loading of the lump breaker roll at the couch than was possible with either a jacket-covered or plain lump breaker roll. The sheet moisture content reduction by 1 to 2% is noticed. Better weight uniformity reduced breaks, dryer sheet into dryer and improved press operation are the advantage found with this concept. The felt design and felt conditioning are the keys to the success of the couch press. The felt must be open, noncompressible and at the same time, have a surface that does not mark the sheet. The combination fabric with 100% synthetic fibres meet all requirements for couch press application.

Dobule Felted Press

Double-felted pressing has already gained wide acceptance. The concept of dewatering a sheet of paper from two sides has in fact been present for many years in paper machine designs. While there are many factors that effected the performance of a double-felted presses, advancement in clothing designs have played a very large part in making this new application of an old concept an overwhelming success. Press load, dwell time, distance that water has to travel and felt construction particularly water handling capacity and flow resistance in the nip are the main factors of water removal in the double-felted press.

Many of the gains observed with double-felted pressing have been made possible by a advancements in felt designs. Felt should be of modern construction with low water flow resistence, high void volume and high air-permeability. The performance capabilities of Batt-on-mesh, combination and multiple-layer base designs are superior to those of Batt-on-Base felts. Higher syn. levels in the web structure give better abrasion resistance. Bases yarns are improved with multi-filaments and mono-filaments replacing spun yarns. This produces higher strength better compaction, ,resistance in the base fabric and enables the felt more easily cleaned and conditioned.

The weakness of double-felted press are rewetting which takes place from both sides and marking of the sheet due to felt surfaces non-uniformity. The benefits include better sheet dryness out of the press section from 2% upto 8% improved runability, reduced sheet breaks, increase machine speed and decreased energy cost per tonne in the dryer section. Type of press roll, heardness of press rolls cover, drive ratio of Top & Bottom rolls conditioning equipments and presssection geometry play vital roles in the performance of double-felted press.

Split Top

On the multi-cylinder machine. the sheet is pressed between two felts in Several successive nips begfnning at the suction drun and continuing through the last primary of main press. One characteristic of these succeseive presses is ponding of water inside the top felt at the nip. This type of Pressing where the sheet and felts reach complete saturation at or before the mid-nip area is known as wet nip pressing which is insufficient resulting into lower quality board due to crushing. ply separation and rail roading.

Improved double-sided dewatering of the board at the suction drum, primaries, and main presses can be accomplished by using separate top felts at the suction drum and primary press section as shown in the figure above.

For best results, it is necessary to separate the top felt from the sheet after the first primary press. The felt is then passed over a slotted suction box to remove the water carried from first primary so that on reentry to the second primary nip the felt is as dry as possible.

Felt or felts entering the nip should have high void volume with the capacity of abosorbing all of the water from the sheet in the nip. Proper conditioning of the felts is equally important for successfulloperation of the concept.

The Mechanics of splitting the top felt are straight forward and can be done by inhouse engineering and maintenance departments. The sheet dryness has improved by 3 to 4%.

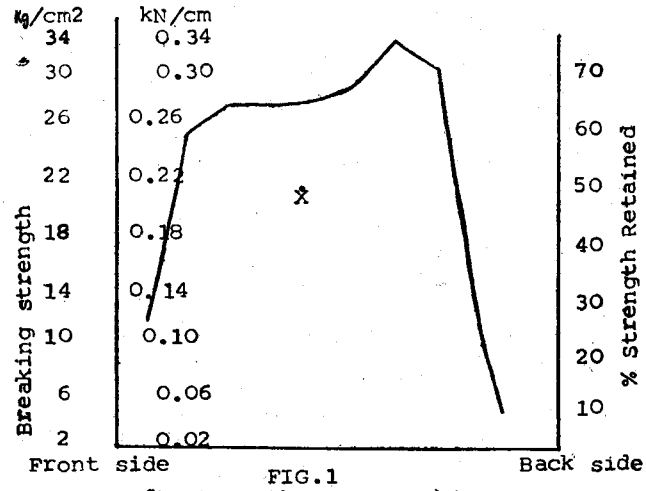

FIG.1
Weft Strength Cross Machine Profile at 0.35 m Intervals

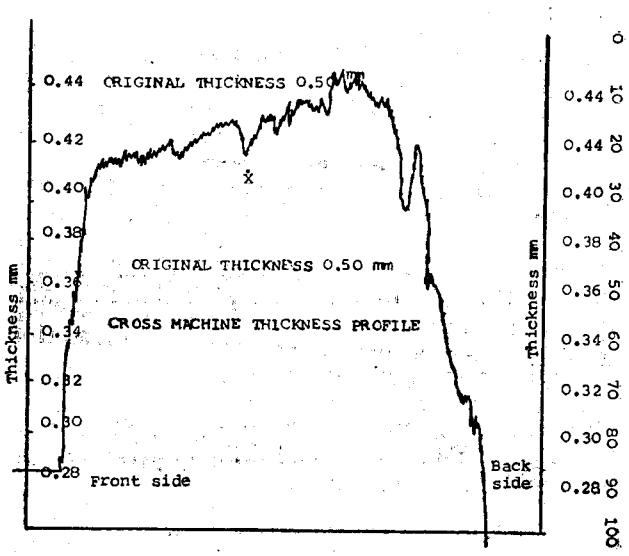

Fig.2:Continuous cross Machine Thickness Profile

Extended Nip

This is developed by Beloit. On the bottom side, a roll being replaced by nip shoes over which a fabric and felt are running. Top roll is also covered with felts. Longer dewell time is the reason for more water removal. Sheet dryness improvement by 7-10% is claimed.

Innovation in Machine Clothing

There are many examples of how the felt improvement of the past 10 years have contributed to the improved water removal, less steam consumption, more uniform moisture profile and better sheet quality.

First on the forming section, synthetic fabric can contribute to improved water removal because they stay cleaner and with stand abrasion and chemical degradation better. In press section the principal innovations are those leading to better water removal. Ofcourse, there are other two important fuctions in the wet felt triangle, i.e. finish and life. Normally we consider all three together, but considerably more importance should be attached to water removal.

As long as paper mills buy felts against standards of days life and cost per tonne, felt suppliers will sell felts that give longer day's life and lower per per tonne cost. But they may not be the best felts for production of quality paper. There are always better felts available for improved water removal, and by using them perhaps at a slightly higher felt, cost per tonne, they can produce more paper in less time with more profit.

The higher synthetic felts stay clean longer as they do not have affinity for dirt that was a problem with lower synthetic felts nor they compact or become boardy quickly. The use of filament yarn could be called the evolution of vertical flow felts.

The mechanical felting by means of needling made possible the vertical orientation of the fibres. When these felts were subjected to an analysis for filling up materials, the dirt was found to be distributed in the felt as below.

1. Machine Direction yarn	...	22%
2. Cross m/c. direction yarn	...	72%
3. Batt	...	6%
Total		100%

This high presence of filling up materials in the cross direction yarns led to the development of weftless felt.

Further studies of returned felts were subjected to the anlysis for loss in caliper, permeability, weight and filling, materials in the felt, Definite pattern could be seen in permeability and Caliper loss but not in weight loss nor amount of filling material. Most felts at the end of useful life lost 35-45% of their initial caliper and 75%-95% of initial permeability.

The reduction in air permeability was found to be more closely related to compaction. This

compaction is mainly determined by nip loading, felt construction, machine speed and filling up material. The filling up materials inspite of their small percentage totally coats the textile fibres. This leads to reduction in fibre to fibre friction and and consequently early compattion.

In other words, the felthas no longer any elasticity, is compressed and becomes stiff and thin.

The effect of compaction can be well understood by expressing it in terms of void volum. Void volume is the empty space within the felt, available for water to fill in.

$$\% \text{ Void volume} = \left(1 - \frac{\text{Fabric density}}{\text{Fibre density}}\right) \times 100$$

Now fibre density is consant factor and hence void volum becomes the function of fabric density only. Fabric density itself depands on its caliper. In short void volume is determined by fabric caliper.

A felt containing 100% Nylone, made at 1200 GSM having 3 mm. caliper will have 65% void volume. If it is compacted by 65% we would then remove a l the empty space leaving nothing but a solid block of fibres. with 0% void volume.

It is also observed that web compacts much readily than base fabric. The fine diameter fibres in the web are unable io resist compaction and as they do compact their fineness has a dramatic filling effect on the felt. Because of this, the Modern Clothings are made in dauble and triple layer base which allows minimum web usage.

The high base to web ratio and use of multi-monofilaments yarns offer felts with not only initial higher caliper but those which maintain their during the useful life. Felt also gets fillled up rapidly during initial period simply because it is so open, there is plenty of room for filling material to lodge. But at this stage its opennes also allows for efficient cleaning and conditioning,

Following are the basic types of Press-clothings.

Batt-on-Base

The needled felts were the first significant departure from conventional felts. These felts consists of a base fabric and an upper batt surface to cover the base fabric. Base fabric resembles conventional woven felts as it contains both machine & cross direction spun yarns. Thus resistence to water flow within the base remains high and pressing efficiency is eliminted by the build up of hydraulic pressure. The flow resistence in the verticale direction is much lower than in the conventional woven felt because of vertically oriented batt fibres. Compaction resistence of these felts is poor because of soft and bulkier yarns. Synthetic contents can go upto 100% syn.

Knuckle-free

This construction makes the use of very small diameter yarn in cross machine direction and spun yarn in machine direction or eliminating the cross machine yarn, and plied mono in machine direction. Resistence to water flow in the machine direction of the felt is lowered because of cross wise yarns, resulting into improved sheet dewatering. Absence of cross-machine yarns also eliminated crosswise yarn marking and its filling up. Moisture profile of paper is also greatly improved.

Batt On-Mesh

The main difference is in the construction of the base fabric which are made from highly twisted multiflaments, twisted fine monofilaments or monofilaments in almost any weave pattern.

Monofilaments used are solid, finer stronger and more rigid than other yarns. Use of these yarns results in a highly permeable base that results in lowered resistance to hydraulic flow during pressing. Solid and smooth yarns do not allow filling up materials to lodge within themselves. The compaction resistence is very high and hence felt maintains higher caliper during its run providing more voids for water to fillin.

Combination fabrics

This construction combines a felt with a fabric such as an inner belt, and therefore effectively converts a press to a fabric press without the need for separate felt and fabric runs. Base fabrics is mainly consists of multifilaments and single or plied monofilaments in double layer weave. During pressing, water from the sheet passes vertically through the batt into the voids of the base. Base maintains its structure integrity even at very high nip loads to effectively capture and had expressed water for subsequent removal away from the nip. Felt should be dewatered properly, otherwise it will run wet and its efficiency for water removal will diminish.

Today, felts with triple layer constructions and making use of all types of yarns are available. They provide very high void volume and great resistence to compaction because of high base to batt ratio.

Non-Woven Fabric

With the base weave eliminated altogether, it has lowest flow resistence in comparision to all other felts and fabrics available. Because of no base yarns, yarn making is eliminated and the opportunity for filling up with dirt and paper fines is greatly reduced.

The disadvantage it has is, very poor resistence to compaction due to the absence of base fabric. It can be used with good results where finish requirement of paper are high.

Crossless Fabric

This is newer design getting popularity. Base is made out of plied monofilaments in both direction without cross overs. Yarns in both directions are just lying over each others.

It gives good moisture profile on account of uniform plane. It stays clean as filling up is very less and does not mark as knuckless are eliminated.

Apart from the base design developments, the use of needling techniques, different tppes of fibers in the batt makes today's clothing more effective to do the demand job.

The use of chemical treatments also improves compaction resistence, fibre shedding, dimentional stability, bacterial or chemical degradation, wet up after installation, filling up and drainage characteristics. Treatments are applied to base, batt fibers and finished felts.

Increased pressing efficiency can be achieved with modern press clothings, effective gains, however, can only be made with a conditioning system which cleans and flushes the felt uniformly, resist compaction and provides optimum drainage in the press nip for long periods of time. Dewatering the felt if a necessary part of felt conditioning because a dewatered felts is more receptive to receiveing water expressed from the paper web in the press nip, minimizing the build up of hydraulic pressure there and hence allowing for better machine runnability.

DRYER SECTION

Dryer clothing for paper machines is currently divided into fabrics and felts. By dryer fabrics is understood a woven structure of high permeability made from synthetic materials in the form of monofilaments or spun yarns and multifilaments with resin reinforcements. By dryer felt is understood a woven and perhaps also needled structure of camparutively low permeability made from both natural fibres and synthetic materials. The two group represent dryer clothing with different characteristics and influence on the drying process and paper quality.

As pointed out earlier drying of paper requires enormous expenses roughly about 2.8 to 3 kgs of steam required to dry 1 kg. of paper. With todays high fuel cost, it is therefore necessary that this cost of drying must be brough down. It is for this reason that lot of work has been done to devise efficient and economic methods of drying the sheet. Innovations were also made in improving drying technology by improving ventilations, machine configmations and condensate removal systems.

In cotton dryer felt the evaporating moisture from the sheet is hindered in its escape by insufficient permeability usually caused by sudden condensation of vapour entering into the felt. This sudden condensation occurs because of the differential temperature of felt especially on the side against the sheet. This usually give rise to humid water film on the surface of the felt thereby reducing its permeability and consequently evaporation is retarded. To correct this situation feltdrying arrangementa are necessary, causing additional consumption.

With the introduction of monofilament Dryer Screens, the vapour condensation in the screen is less and also the absorption of vapour, due to which they run dry as compared to the conventional cotton dryer felt. Vapours escape in the hood due to highly permeable nature of screen. Higher tension can be applied to improve the sheet contact with the drying cylinder thereby drying rate is accelerated.

A generally acknowledged problem with woollen dryer felts is fibre shedding. With synthetic materials less liable to mechanical abrasion, fibre shedding is very much diminished. This has been also one of the reason for changing over from felts to dryer fabrics. Earlier one of the question still often asked whether screens would give marking on the paper, Here the waving technique plays an important role where multilayer design improve surface smoothness. In general it can be said that risk of marking is greater on soft papers than on light grades with high density. This means that risk of marking is greater when the sheet is wetter and bulkier. Seam marking is elimated wtth the use of pin Seam.

Endless fabrics also in multiple-layer design are today available both spliced and round woven, which eliminates almost every risk of marking on sensitive greades, The new Batt-on-Mesh type of Needled felts has definitely solved the marking problem,