Paper Machine Clothing Industry

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In this paper I shall present to you basic technical facts regarding the developments in clothing and its application, that have taken place, particularly very recently, and I shall also cover relevant factors regarding its future growth.

Firstly, however, I wish to cover some factors regarding international growth of the industry and its relativity to manufacture in India.

The establishment of a machine clothing industry is well known to me as I participated in setting up the industry in Australia from 1966. This experience has provided some understanding of the situation in India where you have commenced manufacture and how an importer can still be a very useful faction in the overall development. Because of this new situation the importer must effect considerable change to his operation through applying not only his very latest products but also through providing considerably improved technical liaison and support data. This will assist in the development at the mills. With the considerable reduction in the number of felt companies and the relationships of some to Indian manufacturer there becomes an increasing responsibility on the remaining established importers. This will be met.

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Now with reference to growth in the Paper Machine Clothing Industry the last three years alone have seen very considerable innovations in the design and development of specialised products, that have become more and more compatable to existing machine conditions whilst realising considerable benefit to the paper mill through improved machine efficiency and profitability. These results have obviously been related to the development of new manufacturing techniques and specialised equipment, created in developed areas through application of very considerable finance.

The presentation of very highly sophisticated articles through trade journals is an established situation. I do not propose to identify this paper with a particular development, rather to present to you an overall picture of development in the three areas of machine clothing, namely FORMING, PRESSING and DRYING.

I shall now present you with factors regarding this development.

Forming

In many areas it can be said that by 1976 there will be no metal wires in use. This includes the most difficult applications.

Plastic Forming Fabrics have been applied for a number of years, but most recently there has been considerable effort by the felt manufacturers that has yielded really excellent results. We for example have had successful results with speeds up to 1500 meters/minute (5000 fpm) with very fine weaves up to 39 cms (100") and with widths over 8.00 metres (300"). Any application can now be clothed.

In most applications plastic monofilament fabrics have been applied without any machine alterations whatsoever, even on machines equipped only with table rolls. They have provided lives in the region of 5–10 times that of metal wires for only 2–4 times the cost. The real mill savings in reduced down time for wire changes has been very considerable and also as plastic is less easily damaged unscheduled changes have been nullified. A very important feature is that whereas a metal wire will edge crack then split across the plastic will not. However this may not be a problem in this market.

There is now a very wide range of fabrics available. These can be categorised as (A) plain weave-used occasionally in very coarse pulp applications (B) Straight twill weave-used commonly on many regular applications (C) Broken twill weave-used mainly on fine applications but increasing to coarser applications (D) Double layer weave – a new development being applied to many different applications with the advantage of high stability, longer life, better drainage and lower elongation.

Plastic by nature has a greater len-

gth difference between the slack and tensioned lengths. However through proper application this is not a restricting factor. Once tensioned the plastic fabric will not stretch. Considering an operating tension of say 6 Kgs/cm (25 pli) a bronze wire will elongate about 0.2%, a straight twill weave plastic 1.0%. This is a considerable difference, but as plastic is somewhat elastic it is common on difficult applications to manufacture so that the slack length is less than the minimum installed length through installing the breast roll at tension. More recent developments however namely the broken twill and the double layer plastic fabric have lower elongation namely 0.8% and 0.5% respectively at 6 Kgs/cm (25 pli) tension.

Another feature of the plastic fabric is the new self adhesive type of patch that can be applied in less than two minutes. This is particularly useful where an old fabric is damaged and it is required to last a few more days to a planned shut before removal.

Pressing

This is an area that is receiving much attention, for drying is often a limitation on production so more efficient pressing will improve the output and reduce drying costs.

The development of the new range of clothing has been dramatic, and provides facilities that had they been developed 40 years ago would have meant that the suction press would never have been developed.

The new products provide vertical flow pressing in the most highly developed products area. This means that by applying a plain press with hand nip at high linear pressure water can be pressed from the sheet into incompressible voids within the felt whilst still in the pressure zone of the nip. This water can freely flow in any direction so preventing barriers that would result in sheet crush. This type of product is known as the Batt-on-Mesh range of felts with an incompressible monofilament base. The carrying capacity of this felt is very high, obviously, as it must remove water from the nip area. Therefore good vacuum box facilities and cleaning facilities must also be provided.

The above type of felt is the best possible that can be applied. However there are many machines where facilities are not so good and cannot be improved at present. For this we apply other designs. This has lead to the development of a very special, very open design of felt that is particularly stable and that will not fill up as quickly as other types. It is not a weftless felt but is the 4th generation of that family. This design has had more applications than all the other new designs put together.

Another major development has been the true baseless felt without warp or weft yarns. This is obviously compressible and has been applied in many situations where marking has been a problem. It cannot mark. For felt makers this has been a major breakthrough in design. There are very few mills who have never had felt marking from base weaves. The above three designs are the most applied at present. Obviously due to reasons of compatability one also applies compressible Batt-on-Mesh designs, Batt-on-Base designs, Weftless designs etc.

I would also mention cleaning and water removal. These are separate subjects. Cleaning may be achieved by 5–10% caustic washing during shut periods but it is better achieved through the use of a very high pressure shower. This shower operated at 300–500 psi will maintain the felt bulk, in other words prevent compaction. This will allow the vacuum box to remove the dirt with the water. A full width low pressure shower should be used to help in flushing out the dirt. For removing the water, a two slotted box with $\frac{3}{8}$" (10mm) slots should be used. High air volume will be required so that the voids will be properly emptied. Where an incompressible felt is used a considerable amount of water must obviously be removed and requirements would be higher than with a compressible felt.

Pressing Theory

All development of wet felts in recent years have been aimed towards reducing the hydraulic pressure in the mid-nip area, and shortening the water flow distance. Suction, venta or fabric presses all work towards the same end. A plain press operating with a eonventional felt, whether woven or needled construction, has very definite limitations as to the amount of water which can be removed. When the sheet of paper goes into the press nip with this type of felt, the water must be expressed backwards down the bottom roll, but before it reaches this point it must also pass transversely through the felt. Because the construction is compressible and contains both crosswise and lengthwise yarn,

the resistance to flow is considerable, which not only is detrimental to water removal, but also provides lodging areas for filling materials resulting in the felt becoming plugged, or made up, in a relatively short space of time.

It can be seen, therefore, that if a knuckle or "weftless" type of construction is used whereby the crosswise yarns are eliminated, the water will channel between the lengthwise yarns, the hydraulic pressure will be reduced and more efficient pressing achieved. In addition, the filling material will not have a lodging place and the felt will remain cleaner throughout its operating life.

To take the reduction of hydraulic pressure a step further, a "combination" construction can be used which utilises a base made up from mostly monofilaments which do not compress in the mid-nip area, and therefore provide voids for the water to flow into. Instead of the water being expressed down the bottom roll of the press, it is carried in the base of the felt away from the press nip, to be removed by suction boxes placed on the face side of the felt before returning to the press nip in a dewatered and clean condition, ready to pick up further moisture.

Now to comment on individual designs.

1. Combination of Batt on Mesh felt with monofilament base

This is a needled 100% synthetic combination construction felt which contains both monofilament and multifilament yarns. The base fabrics are totally incompressible and offer the full advantage of vertical flow pressing. Improvements in water removal of up to 5% have been noted in some mills. Shadow marking is almost eliminated on suction presses and, therefore, better quality products are able to be produced when using this design. A notable improvement in felt life has also been apparent in most mills using this fabric. Special variations of this fabric have been specifically developed for multi cylinder board and Yankee tissue machines.

2. Batt on Mesh felt with multifilament base

Of needled 100% synthetic construction, the base of this fabric is constructed from multifilament yarns which results in more flexible fabrics which, for practical reasons, (such as fitting on some older machines) is of definite advantage in certain paper mills. The incompressibility and, therefore, the void area is not as great as with a monofilament base but vertical flow pressing is still utilized.

3. Non-woven felt

This is a100% synthetic needled baseless felt. No yarns whatsoever are utilized in the construction and this results in a felt which *positively cannot mark*. The vertical flow pressing theory still applies and because of excellent flow characteristics within the felt, good drainage and resistance to filling up results. Gains of up to 2% in sheet dryness have been reported by mills using this construction of felt, and life can be expected to be substantially imporved.

4. Knuckle free or "Weftless" felt

This construction is in the knuckle free or "weftless" category and utilizes a combination of monofilament and spun yarns. It is made from 100% synthetic materials and has a wide application on plain or suction press positions particularly where finish and drainage are both prime requirements. Better water removal has been recorded by most users of this type of felt, and great increases in life have also been recorded.

General

The above are constructed from 100% synthetic fibres and are the latest in a family of sophisticated press felt clothing.

All offer substantial advantages especially in terms of water removal, though finish and felt life will also be improved from the use of these qualities. All are applied on the basis of *increased water removal.*

Application and advantages.

It is quite impossible to generalise as to where each type of felt should be used, as this depends on the machine in question, the type of felt cleaning or conditioning equipment operating on the machine, class of paper being produced, and numerous other important factors. However, generally speaking, advantages in greater water removal are not achieved without *pressing harder* and the press section should be constructed so that this is possible.

Therefore, from the ultimate of combination felt design one has to seek compromise in other qualities which may be more applicable to a given application, all of which are

designed to fit in with different sets of circumstances such as are found from machine to machine within the Paper Industry.

Producing high performance press clothing and by taking advantage of these designs, the papermaker can expect;

1. Greater water removal.
2. Higher production.
3. Better quality paper.
4. Longer felt life.
5. Less downtime.

The strange part is that in spite of all these proven advantages with these products, there is a marked reluctance to move towards them as many mills tell us that "adequate water is being removed at the presses", or even if more water was removed, the machine could not run faster because of limitations of one sort or another-all of which we find hard to understand.

Drying

This is an area that has not received enough attention in the past but recently much has been said and achieved in the application of new designs to improve drying and profile.

The number of conventional felts used is falling rapidly in favour of these new designs. Also the needled or batt-on-base felt of 100% synthetic is reducing.

Much emphasis has been placed on the monofilament and multifilament screens which provide high permeability and assistance in pocket ventilation. These have been applied endless or seamed. In some situations where hydrolysis has occurred with polyester, alternate material such as polypropylene and acrylic fibres have been applied with great success.

Whilst screens have been applied on some really fine applications there is a danger of marking on certain papers in the first suction, particularly where the sheet moisture content is high. For these we have applied a Batt on Mesh felt similar to that used on a press. Of course the fibres are different but the design provide permeability together with a very fine surface.

Most recently much work has been carried out on the problem of installing endless screens and a new marking free seam has been developed which is slightly thinner than the rest of the fabric thus preventing marking. This new product is becoming very popular.

Finally in general terms I would mention the problem of screens filling up and reducing drying. Some mills will know about this problem! If filled screens are removed for cleaning they must be reseamed before re-installing. The latest development is the use of very high pressure shower at approximately 1200 psi. This shower will completely clean a screen within 10 minutes during a shut. Ideally mounting brackets should be installed on each position so one shower can be moved about to suit.

The advantage of open mesh dryers are well known to all papermakers and, since their introduction in the late fifties, they have gained wide acceptance in the paper industry.

Work by Nisson Ponton and Kirk and others has provided a much better understanding of the drying cycle, and it is useful now to briefly examine the function of dryer felts and the theory of drying.

Drying Cycle with a conventional felt

The drying cylinder can be divided into Phases I, II, III and IV.

Phase I : The sheet first contacts the cylinder and begins to heat. Little evaporation occurs at this stage.

Phase II : The felt contacts the sheet and begins to press it against the cylinder. Sheet temperature rises rapidly as contact improves. Moisture of the sheet migrates towards the hot cylinder surface where it is vaporised. Vapour then passes back through the sheet to the felt.

The temperature of the felt determines what happens next. If the felt is cool, vapour condenses within it, releasing latent heat to the felt. After condensing, the water must migrate to the back side of the felt if it is to re-evaporate. Any unevaporated water remains in the felt until the beginning of Phase III. if the felt is hot enough, condensation does not take place and some vapour passes through it to the atmosphere.

Phase III : Felt and sheet begin to separate from each other at the start of Phase III. Water evaporates from both sides of the felt as it leaves the cylinder, lowering its temperature. In addition, moisture evaporates from the back side of the sheet. This, and the fact that heat transfer to the sheet is much reduced by the progressively poorer contact with the cylinder, causes sheet temperature to drop.

Phase IV : The sheet leaves the

cylinder. Water evaporates freely from both sides and its temperature drops rapidly.

After passing through the pocket, in Phase IV, the sheet contacts the next cylinder and Phase I begins again.

Drying Cycle with Open Mesh Dryers

When a dryer section is clothed with open mesh dryers, parts, of the conventional drying cycle is altered. Phase I and first part of Phase II remain more or less the same but, as Phase II continues, differences appear.

When vapour first contacts a conventional felt after passing through the sheet, condensation may occur if felt temperature is too low. With open mesh dryers there is little chance for this to happen because of its greater openness. Consequently, more moisture tends to pass through it and be removed while the sheet is still wrapping the cylinder. This enhances drying since more evaporation causes additional cooling of the back side of the sheet, lowering its temperature. This increases the temperature differences between the sheet and cylinder, causing more heat to flow into the sheet to give better drying.

These improvements resulting from open mesh dryers operation all take place while the sheet is still on the dryer cylinder. However, after Phase III, additional drying benefits that are not normally available with conventional felts can be obtained in the pocket. Open mesh dryers cause substantial movements of air in the pocket: This induced air flow contributes to efficient drying. Realization of potential pocket benefits are particularly important on fast machines, since the sheet contacts the dryer cylinder for a shorter time. It has been estimated that more than 50 percent of drying occurs in the pocket at machine speeds about 1000 fpm (300M). Open mesh dryers effectively lengthen the drying cycle by producing significant drying benefits in the pocket-

Open mesh fabric selection

For ease of identification, the range of dryer felts can be split into 4 groups where group 1 is conventional, Group 2 up to 50% synthetic open mesh, Group 3 100% synthetic open mesh and Group 4 denotes fabrics made with special materials. As long term potential with conventional Group felts is limited, we shall concern ourselves with open mesh in the Groups 2–3 categories, when considering the choice of dryer felt clothing.

It is desirable, first and foremost, to run a fabric which will allow the maximum drying while still maintaining an economic life.

In an outstanding experiment which took place in the USA, it was found that when a complete paper machine was clothed with 100% synthetic open mesh dryers, a production increase of at least 3% was achieved, so that in spite of possible increased initial clothing costs, overall *profit* was certainly up, and it is estimated that this will amount to Rs. 2,000,000 per year on this one liner board machine. Limitations arise due to a variety of reasons ranging from lack of machine facilities (e. g. automatic guides), to application limitations due to problems like air pumping on fast running machines. Also, an important factor which affects life, is hydrolysis, which is caused by moist heat, and breaks down the polyester materials from which most open mesh dryers are constructed.

To combat this felts have been developed in both Groups 2 and 3, which are made from materials which will not hydrolyse. In Group 2 a fabric is constructed from acrylic fibre in the lengthwise direction, and with an asbestos and wire yarn in the cross machine direction. The fabric is then resin treated for stability. This felt does an outstanding job on coarse grades as it is a rugged, strong fabric which is much less prone to damage than its more sophisticated counterparts in Group 3.

In the 100% Synthetic Group 3 category, a completely new fabric is being made from polypropylene with acrylic reinforcement which, again, will not hydrolyse and has excellent stability and flex resistance. The fabric will outlast a polyester fabric several times over, especially in the 2nd and 3rd sections of the machine where maximum moist heat conditions are present.

In addition to the above, a full range of multifilament and monofilament fabrics over a wide range of permeabilities to suit any width and machine speed so far encountered can be applied. Also, of special interest to the fine paper makers is a batt-on-mesh needled dryer felt, specifically designed for 1st sections of fine paper machines.

Most of the range can be supplied either endless or with clipper seam, and the recently developed fine non-marking "loop seam" is finding wide application in the industry, again, mainly in the fine paper field.

The future lies in utilizing all the dryer felt advances outlined above, which will result in:—

1. Natural pocket ventilation.
2. Lighter, easier to install.
3. Felt dryers by-passed.
4. Less steam required.
5. Increased operating speed, higher profits.
6. Absence of sheet following.
7. Lowerfelt cost and/or paper cost.
8. Longer felt life, few changes, less downtime.
9. Easily cleaned-openness retained.
10. Improved moisture profile.

Again, however, it is disappointing to us that many times our customers remark, "it does not matter how much steam we use"—or "there are no limitations with drying on this machine," which are put forward as being valid reasons for not using open mesh dryers.

Final Comment

It will be seen that there is a wide range of paper machine clothing products, and the correct choice lies with matching the requirements of the user with the correct product. In this respect, the papermaker is, to a large extent, in the hands of his supplier, but we hope that the afore-going will give those present a better understanding of what can be offered so that advantage can be taken of all the technical advances made over recent years.

I hope that my general comments are of some benefit to you. The illustration of the tremendous development that is taking place internationally, will I am sure serve as a good indication of how machine efficiency will be increased to effect growth towards a continuing prosperity.