Choice of Wet Felts

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SUMMARY

The gradual development in the manufacture of Paper Machine Felts from the early stages to the present day advanced state has been briefly discussed along with the present day understanding of the pressing theory and press configuration. The present day concept of pressing theory has been instrumental in the development of vertical flow felts and press design of no draw presses which has promoted needling technique and use of higher or 100 percent synthetic fibers during manufacture of needled Batt-on-base, Batt-on-mesh, combination, Weftless or Fillingless felts. Maintaining the felts absorbent and clean by use of high pressure needle jet or fan type showers is a further development which has resulted in the improved over-all performance from the wet presses and the felt alike. The cumulative effect of all the recent development have benefited the felt manufacturer, Paper Machinery Builders and the Paper Makers tremendously and the judicious selection of press design, felt quality, felt cleaning equipment to suit the local conditions will go a long way to improve the performance of the Paper Machine and the quality of the product.

INTRODUCTION

The Pulp and Paper Industry is a large consumer of energy in the form of steam and electricity. The cost of energy consumption in this industry is about 15–25% of the cost of production, depending upon the type of raw material used, the type of products manufactured, methods of manufacture and other incidental conditions. In face of soaring energy costs, specially due to the phenomenal increase in the fuel oil prices in the last few years, steam conservation efforts are of urgent necessity. The situation does not seem to improve and will probably be with us for the rest of our lives, unless some new forms of energy can be developed and implemented to replace decreasing fossil fuel. So it is imperative on our part to take some positive steps in the direction of most efficient and economic use of energy, avoiding the wasteful practices in the process.

A detailed study of energy balances of major processes in pulp and paper production provides some interesting possibilities for decreasing energy consumption and improving economy. The greatest opportunity available to a Paper Maker to improve the quality of a product and at the same time achieve substantial economy in energy consumption is in maximizing the efficiency of his machine's press section.

The cost of water removal in the dryer section is much greater than in the press section. Earlier it was considered that press section water removal was about five times less expensive than dryer section water removal. With the rising fuel cost a figure of 15–20 times less expensive, more accurately reflects today's cost situation. Again it is known that 1% improvement in sheet dryness at press can give a 5% increase in production. The dryer sheet from the press can help to speed up the machine where drying is the limiting factor or reduce consumption of steam while running the machine at the same speed.

Good control of the sheet moisture content during production has long been recognized as being essential for optimization of the paper machine operation and attainment of final product quality objectives. Maximization of water removal in the fourdrinier and wet pressing section is important to the economics of the paper making process. Furthermore, a sheet which is too wet entering in paper machine dryers is likely to effect machine runnability. So every drop of water the mill can remove from the sheet mechanically in the press section is money in the pocket. But it was found theortically that we can achieve only a dryness of 48% by mechanical means. So our goal should be to reach as close to this dryness figure as possible before web enters the dryers.

The economics of water removal in the press section of the paper machine though known long ago but concrete steps forward in this direction were taken only very recently. To achieve maximum water removal in press section high press loading was necessary. Earlier when paper maker increased his press loading, he faced with the problem of crushing of the

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paper in press nip. This crushing occurs because due to higher loading the moisture level in the felt becomes high enough to cause saturation in the nip and hydraulic pressure build-up within the felt structure. This hydraulic pressure will not only restrict water flow from the sheet to the felt, resulting in inefficient press performance, but will also distort the formation of the web to relieve the hydraulic pressure in the nip, which is called crushing of paper.

Following the new conceptions in the theory of pressing due mainly to Wahlstrom in which it was shown that the path of water being expressed is preferably in vertical direction through the felt rather than laterally, gave birth to a family of "Verti-flow" process, such as fabric presses, sleeve presses, grooved presses etc. In this family of presses. water moves from sheet through the felt in a path that is more or less perpendicular to the sheet. The advantage of this type of press is that it minimizes the distance, water has to travel in the nip and the resultant hydraulic pressure loss as the water flows through the felt and so maximum pressure in the nip is available to remove water from the sheet.

The roll of the felt on today's paper machine is manifold. It must pick-up the wet web of paper or board, convey it to a press section since the sheet at this point is usually too weak to support itself, and must remove moisture from the sheet through absorption, drainage or both. It must act as a drive, particularly in the case of cylinder machines, and it also must impart finish in varying degrees, depending on particular sheet requirement. Because of these multiple chores, it is specially important that the felt be manufactured to the specific design requirements of the paper machine.

In recent past there has been considerable changes in weave pattern, design and materials of construction of wet felts. These new clothings have been extremely successful on a wide variety of Paper Machines. They have produced significant benefits, that help make paper making more economical and profitable. But it is very important that we must get the proper felts to give us the best service for our specific requirements and suit to our particular press design, furnish, operating conditoins and quality of paper.

To achieve this there must be a felt specification system which quantitatively describes the water processing and finish imparting properties of all felts. Paper Maker should participate in specifying his wet end clothings and felt-maker must relate his design directly to paper making conditions and requirements. Factors such as (1) Chemical treatment (2) Synthetic fibre content (3) Weave (4) Capillarity (5) Reweting (6) Compressibility (7) Fibre shedding (8) Felt marking etc. from an integrated system for felt specifications. Though wet felts are dynamic structures which change continually in response to conditions imposed by the paper making process but clearly the most-obvious result of fixing such specifications will be the increased precision with which felts can be modified to accomodate physical changes in the presses and any change requirement for water removal rate or finish level on paper machine. Failure to follow any one of the demands can result in lower product quality, reduced machine speed, increased steam consumption costs resulting from reduced drying effectiveness or shorter felt life. The faster the machine the lesser margin there is for error in all the various elements of the machine. Paper machine clothing reproducibility will become ever more important to keep steps with the increasing speed of the machine. Also the Papermaker should not forget that practical optimization of pressing will occur only when he operates his felts at its rated capacity for drainage and finish.

Press clothing has passed through several distinct development phases over the years. The type of clothing in use at any particular time has depended on the state of manufacturing technology and the theortical understanding of water removal at the press existing at that time.

At the beginning only all-wool woven felts were used in press section. Only wool had the all round combination of properties that make it the most desirable in the production of paper machine wet felts. Synthetic fibres though offer superior strength characteristics, but in themselves do not have the absorbency, resilence or cushioning that the base yarns of conventionally woven felts act as barriers to flow of water within the felts and these barriers continued to contribute to the filling problems of felts. Also yarn marking occured in the paper. Still all wool woven or needled felts are used where finish is critical.

To take advantage of the vertical flow of water in the press nip, needled felts were introduced which improved water removal significantly, also because of the inherent characteristics of needled felt helped in resisting marking and compaction. But still they retained the short comings of the woven felts, filling trouble in base yarns. Originally fibre shedding was a problem with needled felts, but improved needling techniques and chemical treatment have made it possible that needled felts do not shed more fibres than a conventional felt. Gradually synthetic contents in felts were increase to give better abrasion resistance and better life. Now high synthetic content wet felts are universally employed on modern high speed machines entirely due to highly developed needling technique.

In the last decade radical changes in felt construction have taken place with increased use of synthetic fibres and advanced technology in needling, to provide fabrics which embody a concept of vertical flow principle as closely as possible. Several new forms of press clothing have emerged in recent years that perhaps have been the most dynamic in the history of press clothing development. They are :

1. BATT-ON-BASE

In these felts base fabric is woven of spun yarn, both machine and cross machine direction, into which a web of fibre batt is needled.

2. WEFTLESS

In these felts base fabric is woven of spun yarn in machine direction only with no cross machine yarns. A web of fibre batt is needled, on to it.

3. BATT-ON-MESH

In these base fabric is woven with treated or untreated multifilaments in machine direction and multi or monofilament in cross machine direction with a web of fibre needled on to the surface. They produce relatively incompressible structure with very high void area in the felt for improved drainage at press.

4. COMBINATION

This is actually a combination of fabric wire and a felt. To a two or more layers of incompressible base fabric a web of fibre batt is needled only on the surface. So there is a base of rigid fabric with high void volume.

5. NON WOVEN

These are manufactured with an all-needled fibre batt to a base which is soluble in water or solvent providing a completely non-woven felt. Some of the physical characteristics of the felts are given below :

TABLE—I

COMPARATIVE PHYSICAL PROPERTIES EXPRESSED IN CFM/SQ.FT. OF FELT

	Saturated Moisture	Vacuum Dewatering	Air permeability
Conventional	0.80	0.26	20
Batt-on-base	1.20	0.43	26
Weftless	1.40	0.57	42
Non-woven	1.50	0.80	52
Batt-on-mesh	1.60	0.78	70
Combination	1.65	0.82	75

Saturated Moisture : is a measure of the amount of water absorbed by a felt under static conditions.

Vacuum Dewatering : measures the ability of felt to release water to suction box.

Air Permeability : is the measure of openness of a felt.

TABLE—II

RELATIVE FLOW RESISTANCE

Clothing	Flow resistance		Ranking
	L	X	Z
Conventional	100	100	100
Batt-on-base	98	96	36
Weftless	30	23	42
Non-woven	18	12	16
Batt-on-mesh	25	29	44
Combination	13	15	37

L = Lengthwise machine direction
X = Crosswise machine direction
Z = Vertical direction.

To improve pressing efficiency the following rules must be taken care-of :

1. Shorter the water flow distance in the nip.
2. Reduce the hydraulic pressure in the nip.
3. Improve the pressure distribution in the sheet.
4. Optimize the vertical flow.
5. Minimize the sheet rewetting.
6. Provide water receptacles.
7. Dewater the receptacles clean.

With the evolution of these new high synthetic construction felts we see that felts are seldom removed from the machine because they are worn-out. They are generally removed because they are filled up or compacted to the point where they no longer handle water uniformly and lack the drainage capabilities to maintain a high level of pressing efficiency. To maintain the bulk, porosity and permeability of a felt through out its effective life a properly designed conditioning system is essential. In particular rules 6, 7 and 8 are very important in felt conditioning since they directly influence rules 2 and 4 to a major degree and rules 1, 3 and 5 to a minor degree. Great benefits are potentially available to Paper-Makers from these new fabrics and suction box equipment and very high pressure water shower. These very high pressure (400 lb/m² or more) needled or fan sprays are applied to inside of felt directly opposite a vacuum box or suction pipe. The quantity of water used is small, because it is mixed with air. This system is suitable for high speed machines on which only a limited time is available for cleaning.

The maximum operating speed of most paper machines is determined by the dryness at the first open draw. It is known that paper web is very fragile when it is still wet. So if the tension at the open

draw needed to separate the sheet and change its direction exceeds tensile strength of the paper at that point, the sheet will break. The forces involved are dependent on variables such as speed, basis weight, dryness surface characteristics etc. Fig. I shows a typical example of the relationship between wet web strength increased four fold for a dryness increase of from 20% to 35%.

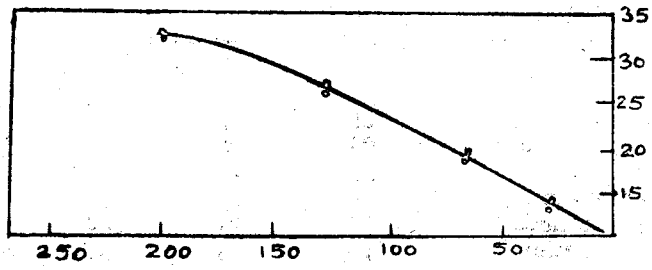

Fig. 1

Standard of performance of different types of felts are continually being improved and the particular application of a felt together with the economics of its use (cost per tonne of product made), decides the type to be installed.

Some mills have found that the extra cost of 100% synthetic felts is not balanced by their longer life only as in their case felts are changed on a set schedule during shut downs and the extra cost is therefore unjustified. The type of machine and product quality is the most important parameter which determines the quality of felt to be used.

CONCLUSION

The story of felt design application has been one of specialization. Earlier there was a knowledge gap between paper maker and feltmaker. Felt making was only a textile business then. Papermaking was a "One man" show. Paper-maker selected the felt type, bought the felts and installed them. Feltmakers only hired the services of some persons with a little paper mill experience as Salesman.

But with the fast running machines and special need of different types of felts to meet the rigid quality specifications of paper, the need for a technically trained and qualified person to act as Liason between the paper-maker and the felt-manufacturer is essential.

When the felt designer and his service engineer start enquiring why certain things happened, rather than just accepting the fact, in co-operation of the paper-maker, then only they will be able to make changes and improve their design to meet the need of paper industry.

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