Modern Press Felts

Jan Linderot

There are two main reasons for the rapid strides made with presses and felts in recent years–one a better grasp of the pressing sequence, and, as far as felts are concerned new materials and production methods which have created the right conditions for longer life and better water evacuation.

Developments have of course been concentrated in the field of needled felts making possible the inclusion of an adequate amount of synthetic fiber in the felts, and also giving manufacturers more room for manoeuvre when it comes to combining various properties, for the optimization of felt function.

Needled felts consist of two main constructional parts–base weave and batt–which can be adapted to each other in order to obtain the optimum construction. The utilization of these different possibilities for variation has given birth to different types of felt which have obtained their names from the manner of their construction, for example weftless or fillingless felts where the cross direction yarns have been eliminated, batt–on–mesh felts so named if hard, incompressible yarns are used in the base weave, as well as fully–synthetic types which have a total absence of wool in their make–up. Before going on to describe these types individually it may be worth mentioning something of the general development of normal type needled felts.

Needled felts in general

When it comes to running properties it is the machine–direction yarns which play the most significant role. Felts must not be too "dead", by which we mean that they must have a certain amount of stretch otherwise they will be extremely sensitive to the conditions of the machine, roll crowning and stability for example, they will be difficult to guide and easily tend to fold.

There is another reason for desiring elastic, stretchable felts. If felts are stretched coming up to pulling rolls and then drawn together after passing the nip the movement of the yarns produces a pumping action in the felt, thus making for much more effective cleaning than when less stretchable warp yarns are used and the pumping effect reduced. On some positions tending to clog felts rapidly, a change to more elastic machine–direction yarns has doubled and, in some cases, trebled felt life. This stretchability must not however be plastic, in other words irreversible, so that felts eventually become too long. The characteristics of various yarns in this respect can be seen from Fig. 1.

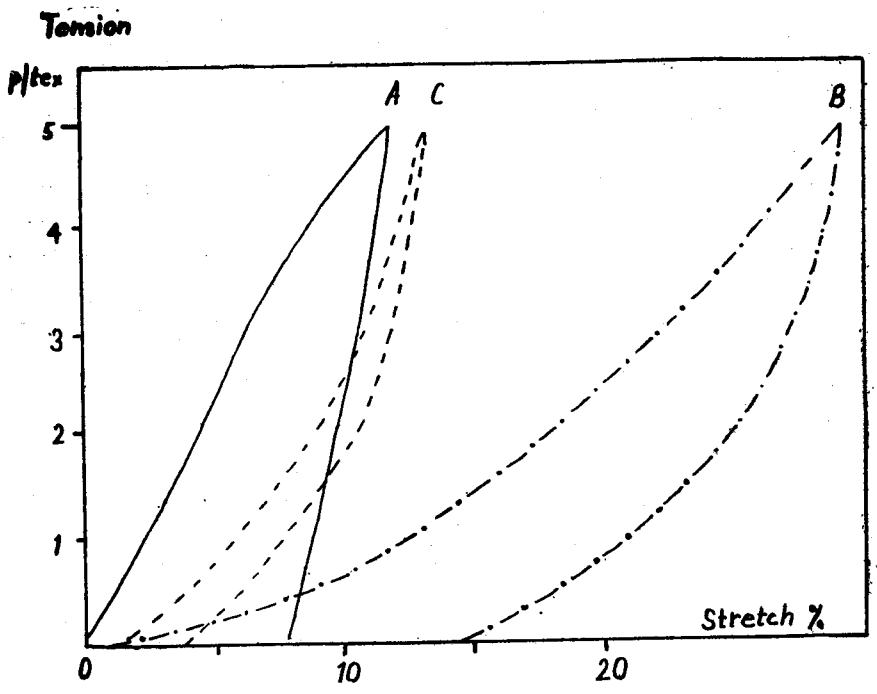

Fig. 1. Elastic Properties of Various Yarns

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Yarns of type A have such a high Elasticity-modulus that problems can be expected. Type B has a lower E-module and can be used without risk for felt creasing, but due to the large initial stretching, a lot of which is plastic and irreversible, there is a risk that the felt might become too long for the stretch adjustment to cope with. Yarn C, comprising a mixture of multifilament and spun yarn, has an E-module lying between A and B also has less initial stretch, with only a very small proportion of the stretch being of a plastic or irreversible nature. Therefore a steadily growing number of modern felts include multifilament in the machine-direction yarns.

The influence of cross-direction yarns on felt running properties is less significant, which has led to them being reduced and replaced by more batt. It can be seen from this that the construction of modern needled felts is becoming all the more on the lines of the weftless types, thereby bringing the advantage of higher lateral permeability. Now a days a larger proportion of felt weight is accounted for by the batt than was the case with needled felts a few years back. When highly permeable felts are required the batt is needled down in such a way as to leave underside clear of needled-through fibres. This produced a permeable, open felt with a compressible resilient batt layer which is still well anchored to the base weave. The resilient batt layer is a great help as far as felt cleaning is concerned and, additionally, the felt is better able to absorb the shearing forces from rubber roll covering and prevent these from being transmitted to the sheet.

The properties of the batt are of extreme importance for the resulting dryness of the sheet after the press, which for thin sheets in the last presses is determined by the amount of rewetting. The higher the elasticity of the batt and the smaller capillaries formed by the batt fibres the smaller becomes the rewetting and the higher will be the dryness. Since rewetting is a typical surface phenomenon there is no need for a homogeneous batt make-up. It is enough if the top layer, which comes into contact with the sheet, comprises fine capillaries. On the other hand the underlying batt layer can be made up of coarser fibres to produce high permeability at the same time.

This construction also makes the felts susceptible to plugging, since it is easier for the particles which have passed the fine fibre layer to pass through to the coarser layer beneath. There is also a lesser marking tendency, as the coarser fibres in the intermediate layer bridge the voides between the base weave yarns better. Mechanical durability will be greater as batts of the same permeability can be made thicker thereby allowing a lump of pulp to pass through the nip without damaging the felt.

It can be expected that this differentiation of felt construction in order to combine different part-properties is going to be employed on a wider scale.

Batt-on mesh felts

Batt-on-mesh felts work on the divided-press principle. The stiff underside should not be compressed in the nip but be able to accept the expressed water in its void area without any hydraulic pressure forming in the felt. This avoids the formation of a water barrier, as in a plain press. In order for this principle to work as intended the stiff reverse side of the felts must be practically emptied of water before entering the nip. For water removal of this knid plain presses are not good, but instead felt suction boxes or suction wringer presses will be needed. For these reasons we have made a close study into the dewatering function of felt suction boxes. As some of the most important details we can mention that felt suction boxes with straight, 8-10 mm wide slots have proved best and that with a vacuum of 3-4 m. w. g. an air requirement of 0.06 m^3/min. cm^2 must be anticipated.

It is quite obvious that where batt-on-mesh felts come to the fore, is in positions with large volumes of expressed water. Here a hydraulic pressure drop in the nip can create a greater safety margin against crushing or, on the other hand, it may be possible to increase press loading and raise dry-content. This does not mean however that the successful use of Batt-on-mesh felts is confined to plain presses. They can often be used to advantage in suction presses, fabric presses, and grooved-roll presses.

The most typical of batt-on-mesh felts are those having a monofilament mesh built in on the roll side. The type has the largest void volume when under compression, and can accept large volumes of water and are therefore used e. g. on pulp drying machines, even in positions like 3rd fabric presses.

Even more flexible types with a roll side comprising monofilament and multifilament woven-in in some cases with an intermediate weave of spun yarns, and onto which a batt layer is subsequently needled have given excellent results in various types of positiosn.

It is not suprising that this particular type has been greatly appreciated on board machines where the large volume of water expressed makes a batt-on-mesh felt necessary at the same time as there is a particular demand for a non-marking felt. Despite the fact that this type of felt contains monofilament in the cross direction the three-tier construction means that there is little marking tendency. This type has, for example, been used in 3rd Plain Press positions, 2nd Venta-Nip presses and suction press positions. Reports speak of an excellent dewatering effect. which is of course the most important, but aslo of long running times of 100 days and more.

In other types of batt-on-mesh felts the monofilament material has been abondoned and replaced with twisted multifilament. There is also batt on both sides of the felt as a rule. It is not absolutely necessary for the incompressible filament yarns to be orientated on the roll side of the felt. The main thing is for one of the layers in the felt to be incompressible and able to hold the water. Batt fibre on the roll side of the felt produces high bulk which is most useful in suction presses for eliminating shadow marking and besides that it reduces the wear on the suction roll rubber cover.

These types of batt-on-mesh felts have a wide field of use such as suction press felts for fine paper grades and board, top felts on board machines and bottom felts on Yankee machines. On the latter, which require particularly open felts, there were great problems in replacing conventional woven felts by normal needled types. This difficulty was easier solved with batt-on-mesh felts.

Batt-on-mesh types are sure in future to make more conquests in new positions even though, through the development of weftless and baseless types, feltmakers have already sought other lines of development.

Weftless felts

The name in itself betrays the kind of construction used here. The cross-direction yarns can be completely eliminated or can be of such fine structure and low frequency in the weave. It can be of the type of material which will disintegrate when needled in thc fibre locker, or be dissolved in the subsequent wet treatmetn.

Due to the small proportion of cross-direction yarns these felts have rather special properties. The quantity of batt can be raised to utilize the drop in yarn weight and so produce a soft, compressible felt. The points of intersection, the "knuckles" between machine-direction and cross-direction yarns are eliminated, and with them the risk of marking and-most important-an even distribution of pressure throughout the felt is obtained. With no cross-direction yarns in the path of the water flow a high degree of lateral permeability is obtained with little clogging tendency.

Naturally in thesc felts the construction of the machine-direction yarns is of vital significance. It is common to use combinations of fully-synthetic spun yarns and multifilament in order to give the felts the necessary elasticity. The character of the yarn can be varied completely according to the importance attached to even pressure and freedom from marking, or, if the highest possible permeability is required, when hard twisted yarns can come into the picture.

Weftless, or fillingless felts, have a wide range of uses but the most important are those where freedom from marking is the prime demand, for example in final plain presses on fine-paper machines. Exellent results have also been obtained with these felts in grooved roll presses for the production of fine grades and magazine paper. One example we can mention is a Venta-Nip press for magazine paper (300 m/min) where ordinary needled felts became too plugged after 600 hours. Here a weftless type ran three times as long without any clogging problems.

The particular demands placed on the Making or Mould felt on board machines, with the need for permeability combined with freedom from marking and stable-running, can largely be met by weftless felts. The even distribution of pressure is also of great importance as far as

Glazing felts are concerned and weftless types have outclassed conventional felts by giving a better gloss.

This type of felt also comes in for making thin paper grades on Yankee machines. Apart from giving an even impression a fine capillary paper side is vital for providing a high dry-content. The even impression is provided by the weftless construction and the fine capillary structure is due to the purpose-chosen batt fibre material as well as the method of needling.

Weftless felts have done well on two-felted Yankee tissue machines, having proved to need little running-in as well as giving a good dewatering effect so that the machine has quickly come up to the highest operating speed.

Baseless felts

Felt types completely free of cross-direction and machine-direction yarns, comprising of a needled batt only, are called baseless, yarnless or non-woven felts. These represent quite the opposite to the batt-on-mesh felts with their incompressible yarns. Despite this the baseless felts can have a differentiated construction with coarser fibres on the roll side than on the paper side. This ensures that, under compression, permeability will be just as high, if not higher than batt-on-base needled felts.

Fig. 2 shows the permeability ratings for a traditional needled felt, a batt-on-mesh felt and a baseless type, where the baseless felt can be seen to lie between the two others. Another important factor is how to retain felt thickness

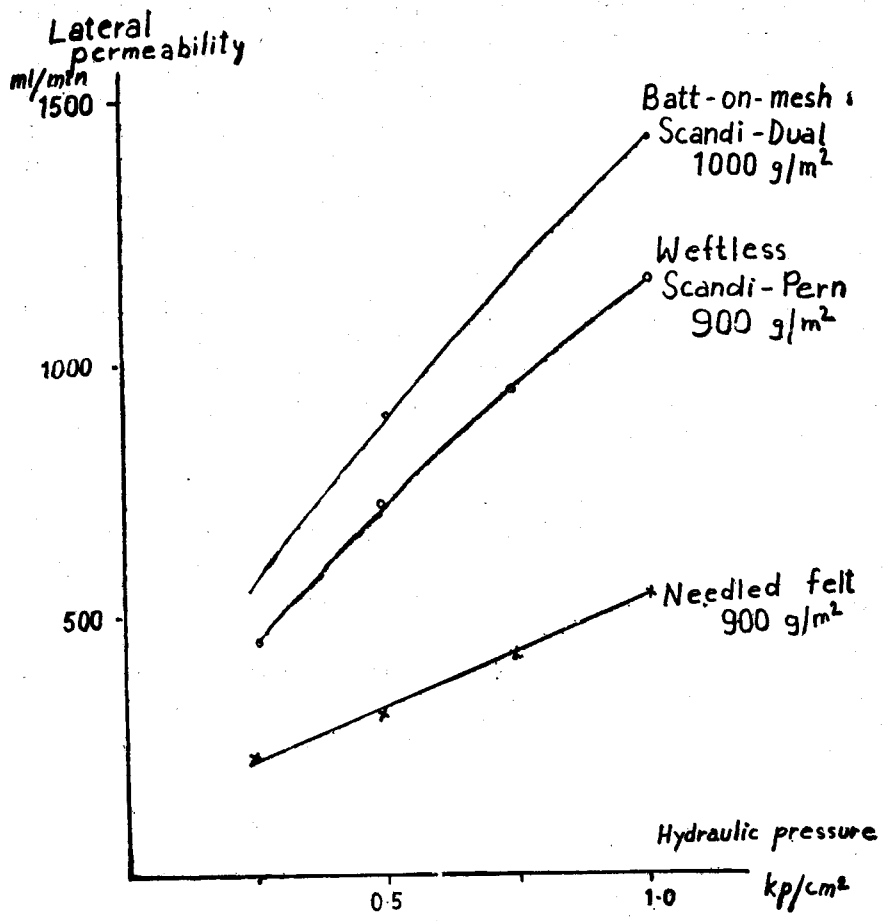


Fig. 2. Lateral Permeability in Relation to Hydraulic Pressure

and permeability in operation. The following table shows how these values have altered after 24 hours running in a test press (speed 450 m/min, loading 50 kp/cm).

Type of felt	Weight g/m²	Tickness in mm		Lateral permeability	
		initial	After 24 hours	Initial	After 24 hours
Baseless	1160	3.5	2 6	660	480
Weftless	1150	3.3	2.5	400	300
Batt-on-mesh	1210	3.1	2.7	1850	1160

The baseless type has kept its thickness and permeability even if the permeability rating cannot compare with that of a batt-on-mesh felt.

With the felt consisting of a needled batt layer the fibres form more or less vertical pinhole-channels which provide the felt with transverse permeability and favourable compression as well as expans'on properties. The baseless construction not only means high permeability but also little tendency to clogging, with no yarns to prevent the water flow and to catch particles of dirt flowing through the felt.

Their high lateral permeability gives

baseless felts a wide scope and they can replace ordinary needled types or weftless felts in many positions. This is particularly true in the final positions on fine-paper machines for example, where a high standard finish is the overriding demand. Baseless felts have a natural area of use in transverse-flow presses like grooved roll, fabric and sleeve fabric presses. The high transverse permeability in the felt together with the incompressible void area in the fabric and in the roll give very low hydraulic pressure. The right felt thickness must then be selected to prevent the grooves or fabric from marking through onto the paper. A felt weight of 1000 g/m² is enough to ensure this. This is no heavier than normal farbric press felts would be.

The development of baseless felts is still in its infancy and despite the simple construction it ought to be possible to obtain many different varieties, either by using different fibre and different layers or by altering needling techniques and after treatments.

Fully synthetic felts

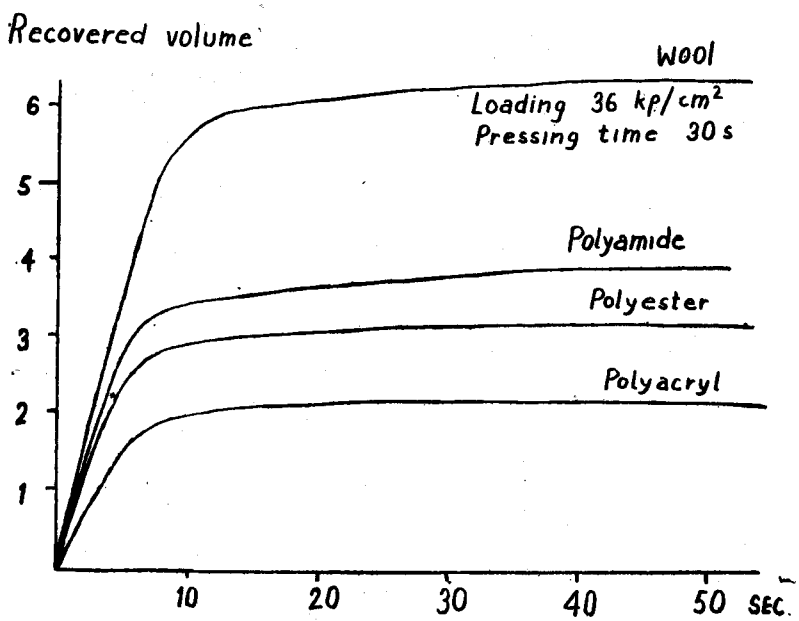
Felts are classified in various ways, partly according to their area of use and partly according to construction. To categorize them according to synthetic content would not be particularly suitable since fully-synthetic felts belong to many different groups like the ordinary needled variety, weftless and batt-on-mesh felts. Many of these types have a fully-synthetic base weave, but various felts differ from each other by their batt, which is either a mixture of wool and synthetic fibre or consists solely of synthetic material. It is mainly those types with a 100% synthetic batt which possess those special properties which could be of interest to discuss in more detail.

It is a generally known fact that fully-synthetic felts possess excellent durability and it is mainly this one thinks of when talking about them. In those cases where a felt has been removed from the machine purely because of heavy wear there could be reasons for considering whether a changeover to fully-synthetic felts would be economical. We know of cases where conventional felt running times have been improved 10-fold by changing to fully-syn thetic needled types.

In may cases however this extended running time has had to be paid for in terms of a lower dry-content, this being due to a heavier rewetting from the synthetic batt. This in turn is due to the inferior elasticity of synthetic fibre compared with wool. Just how superior wool fibre is in this respect can be seen from Fig 3. This property becomes particularly apparent when producing thin papers on final press positions.

When dry-content is a critical factor fully-synthetic felts should only be used in the early presses. With thick sheets, like board, rewetting is of less significance, and fully-synthetic felts are often used to advantage in all press positions.

On the other hand half-synthetic felts are often to be preferred in the final presses as here there is risk of scorched streaks appearing, should lumps of pulp get stuck and roll in front of the press nip. There is less risk of this with half-synthetic felts. Of course the woollen fibre could be



Expansion Sequence for Wool and Synthetic Fibres in a Wet State

Fig. 3.

replaced by a fibre like Nomex which is insensitive to heat but the elastic properties of this yarn do not suit it well for use in press felts.

The lower elastic recovery of synthetic fibre makes felts comprising solely of this material easily lose their bulk due to an irreversible compaction of the batt. One method of reducing this effect is intermittent cleaning of the felts with high-pressure showers. The sharp jets against the batt side of the felt provide a mechanical conditioning which opens up the compressed batt.

The clogging tendency of fully-synthetic felts is not altogether worse than that of part-synthetic types, but the inferior elastic recovery has a certain negative effect. Even though washing in caustic soda is often a very effective method of cleaning, the synthetic material does not spring back to its original state, despite the fact that dirt and size substances have been removed. In these cases showering with high-pressure can have a favourable effect.