Reaching Unforeseen Levels of Performance

Advanced forming fabric technology improves quality and productivity, while reducing energy consumption.

By Steve Cole

During the last decade of papermaking, the industry experienced a literal explosion in the application of support shute binder (SSB) forming fabric technology. SSB fabrics, developed and introduced almost 13 years ago by Weavexx and Huyck. Wangner, revolutionized the industry by overcoming several inherent limitations from conventional double-layer and triple-layer structures **(Fig. 1)**. Huytexx fabrics as they were originally known, utilize a unique and still patented reverse-pick stitching pattern that provided the world's first plain-weave top triple layer with a binding concept that did not exhibit interlayer wear. The structure provides straight-through drainage, which allows a dramatic increase of fiber support, compared to single and double layer fabrics. This resulting improvement in drainage led to better dryness and excellent retention.

However, with increased fineness (higher CMD and MD yarn densities) of the SSB fabrics, the top side open area is reduced, leading to higher drainage pressure and lower drainage rates. The operational window is reduced, vacuum levels increase, drive energy increases and sheet solids go down.

With today's increasing demands for higher machine speeds with improved sheet formation, SSB has reached its technological and operational ceiling for delivering the ideal combination of sheet properties and drainage capacity while providing optimal energy efficiency.

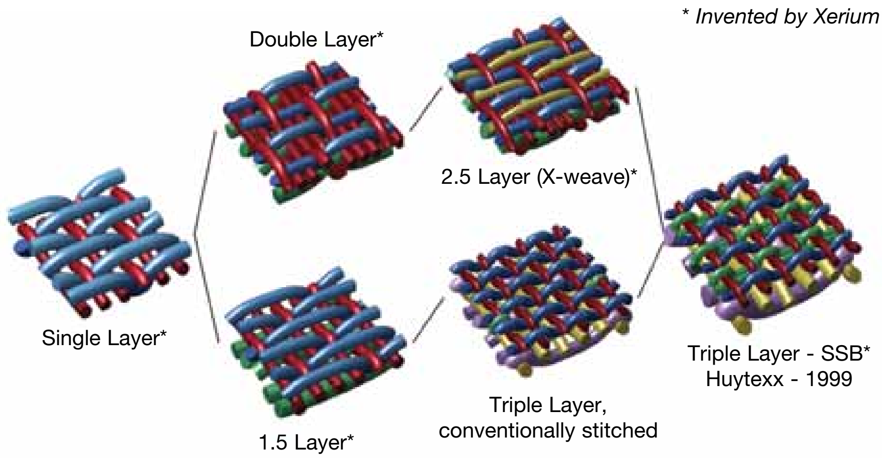

Figure 1. Progression of Synthetic Forming Fabric

In addition to the requirements for structural changes, papermakers are seeking relief from high energy costs in the ever-increasing competitive landscape of the global paper industry.

This article will review new structural and material technology developed specifically to address these modern demands.

NEW GENERATION STRUCTURES

In order to meet these new challenges for graphical paper grades, several new-generation forming fabric concepts were developed to overcome the aforementioned limitations of SSB.

As a functional review, the paper furnish includes fibers, fillers, chemical components and water. The forming fabric's primary objective is to filter the fibers and fines from the water. However, even the finest forming fabric structures are unable to mechanically retain a fines particle on their own. Hence, first pass retention — the build-up of the initial fiber matt — is critical.

Only the forming fabric directly influences this initial sheet forming process. Further sheet forming, retention and drainage performance are controlled by the initially-formed fiber matt. Therefore, the overriding purpose of the forming fabric is to properly construct this initial fiber matt.

Forming fabric performance is mainly defined by its characteristics provided in the initial drainage section of the paper machine. As a result, Xerium development engineers shifted the focus from the fabric structure to a specially formed drainage channel concept providing optimum sheet formation, quality, and machine efficiency.

This ideal initial fiber matt must provide:

- proper sheet formation, due to mobility of the fibers
- retention of fines and fillers (matt is always finer than the fabric)
- open structure, to facilitate water removal over the whole former at lower vacuum levels without sheet sealing.

Actual field results prove that the initial fiber matt must be porous and not densified. Otherwise the sheet becomes "sealed", reducing the overall drainage rates. The vertical-downward hydraulic velocity on the sheet side of the fabric has a crucial impact on the porosity of the initial fiber matt. A higher surface open area provides a lower flow velocity and produces a more open initial fiber matt. In order to provide this more controlled drainage environment, the surface open area on fabric's machine side is reduced.

Rapid customer adoption of Xerium's new Engineered Drainage Channel (EDC) product line proved this concept which is diametrically opposed to the conventional wisdom in the paper industry, much like the SSB was 'out of the box' thinking ten years ago.

What does a fabric's optimal drainage channel look like, in detail?

- Most fibers exiting the headbox are MD oriented. It is a well-known fact that CMD oriented forming fabric meshes provide the highest mechanical fiber retention. Therefore, the sheet side hole needs to be CMD oriented
- Regarding drainage capacity and fines/filler retention, a high sheet side surface open area is critical. Therefore a volume of water can pass though the forming fabric at a relatively low flow velocity on sheet-forming level
- Conversely, to control this flow for optimum and smooth sheet forming, a reduced open area on the machine side is required
- The caliper of the fabric, and its corresponding Z-direction hole length, needs to be minimal to ensure rapid water removal
- And, to ensure steady-state performance throughout fabric life, caliper loss needs to be minimal.

The development of technologically advanced forming fabrics has progressed to unforeseen levels.

ENGINEERED DRAINAGE CHANNELS, OR EDC

The patented EDC concept was developed by Xerium engineers and confirmed by in-house laboratory tests using the FRET drainage tester. In addition, Grenoble University corroborated the concept and modeled the flow velocities over different depths through the fabric. The surface open areas in Z-direction control or influence the velocity of the water flow **(Fig. 2)**.

To apply the optimum channel we are using an internally-developed tool to simulate the drainage channel, the average mass distribution in Z-direction, and show the porosity

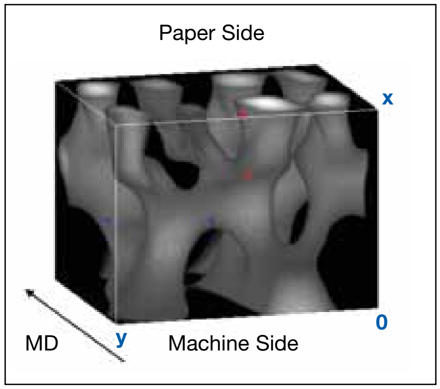

Figure 2. Drainage Holes - Forming Fabric.

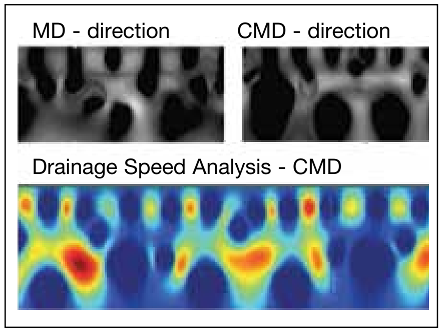

Figure 3. CMD and MD Drainage Map.

or free surface over the whole fabric caliper in MD and CMD direction. This revolutionary approach allows for development focused on the fabric's holes, not on the mesh.

The exact channel specifications are created by different ratios between the sheet side and machine side CMD and MD yarns. In addition, modifying the yarn diameters and/or mesh densities on the sheet side or machine side has an influence on the shape of the channel. Application engineers can now create a special channel for each application world-wide, customized on individual customer requirements **(Fig. 3)**.

NEW GENERATION FABRIC MATERIALS

In addition to major new developments in forming fabric structures, Xerium has invested significantly in the development of drag load reducing material technology. This research was conducted in response to two major market factors. First, since a large population of older machines are operating at or near their drive limit, any reduction in drive energy helps to stabilize the operation and to optimize costs, and often to allow for incremental speed increases without capital investment. Second, even on more modern paper machines which are equipped with sufficient drive power, reducing drive energy contributes significantly to reducing the production costs.

Since the forming fabric is in constant contact with the dewatering elements, it creates frictional forces and therefore losses of energy. For some fabric styles, the loss is significant therefore requiring the machine to overcome a high drag load in order to run the fabric. Obviously this situation creates a drawback for the fabric as well. Reducing drag loads in the forming section offers the papermaker the possibility to reduce the energy consumption in the wet end.

For example, on a fourdrinier machine, there are a number of locations of energy loss:

- Friction between the different mechanical pieces of the forming section, rolls, ball-bearing, etc.
- Slippage effect between the rolls and the fabric. If the slippage speed between the fabric and the roll is zero, then energy loss is zero. However, if slippage speed is greater than zero, there is friction and so energy loss and wear on the rolls.
- Friction between the fabric and the dewatering elements.

It is generally accepted that the energy loss due to the friction between the fabric and the dewatering elements is estimated to be 15% in parts 1 and 2 **(Fig. 4)** and 80% due to the vacuum boxes in part 3. The remaining 5% are friction in the roll bearings and other miscellaneous losses. So, according to this thought process it was more fruitful to focus on the high vacuum boxes. The higher the vacuum applied from a box, the higher the drive load. The vacuum level depends largely on the sheet formation process. If the sheet structure is formed "open" enough atop the initial fiber matt, it is more easily dewatered, thus requiring lower vacuum levels resulting in energy savings in drive energy. The aforementioned EDC technology already provides this capability in the structure.

FORMING FABRIC MACHINE SIDE MATERIAL

Historically, some fabrics were offered with materials targeted at reducing drive load energy. However while those materials did reduce the friction coefficient of the fabric, they provided shortened run times. Another drawback of those materials was a significant limitation in the available diameters, which severely limited the application scope.

In order to overcome these limitations Xerium partnered with a yarn manufacturer to develop EnerSTAR™.

EnerSTAR combines unique machine side materials which deliver low friction attributes with very high abrasion resistance. For the first time, the drive load can be reduced without compromising fabric life or stability **(Fig. 5)**. What's more, EnerSTAR is applicable to a wide range of forming fabric positions and grades, due to its availability in more yarn diameters.

The combination of EDC and EnerSTAR create opportunities for even larger benefits:

- lower drag loads due to less friction of the forming fabric on the dewatering elements
- lower drag loads due to lower vacuum levels
- lower vacuum levels due to easier water removal from the improved sheet structure
- higher sheet solids on pick-up
- improved runnability
- possibility to run lower headbox consistencies resulting in improved paper formation at higher or constant retention.

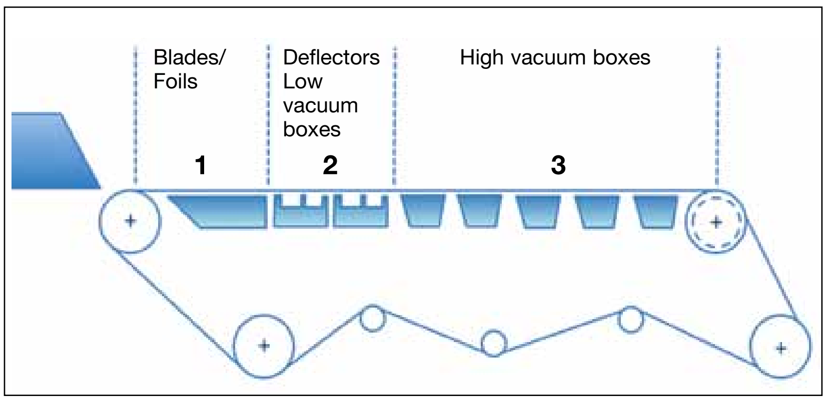

Figure 4. Dewatering elements on a Fourdrinier paper machine.

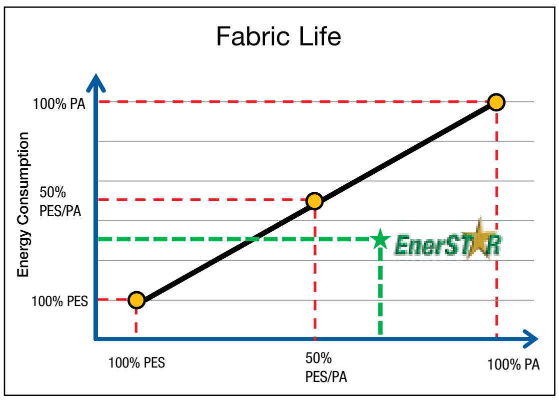

Figure 5. EnerSTAR for reduced energy and extended life.

CASE HISTORIES

The following are actual mill case histories with documented ValueResults where each forming fabric was installed.

Graphical Grades

Location: Asia
Former: Bel Baie IV
Grade: uncoated freesheet, copy paper
Speed: 4,200 FPM
Previous Fabrics: SSB
Problem: Customer experiencing poor sheet quality/white spots, high retention aid usage, high draws, sheet curl.
Result: Installed Formexx fabrics on both positions.

- quality issues resolved
- reduced retention aid by 25%
- reduced refining energy
- reduced draw
- reduced steam consumption by 10%

Total annual value of approximately $2 million.

Location: Europe
Former: Gap former
Grade: uncoated groundwood
Speed: 5,200 FPM
Previous Fabrics: SSB
Problem: high drive loads, unable to reduce energy sacrificing sheet quality.
Result: Replaced SSB fabrics with Finetexx fabrics on both positions.

- improvement in sheet structure due to EDC
- sheet quality parameters achieved
- more open sheet required lower vacuum
- drive reduction of 7%

Total annual value of over $80,000 in power savings.

Location: North America
Former: Gap former
Grade: uncoated groundwood
Speed: 4,650 FPM
Previous Fabrics: SSB
Problem: Customer looking for improved performance, drainage.
Result: Replaced SSB fabric with Finetexx on conveying position.

- improvement in sheet structure due to EDC
- sheet solids improved nearly 2% points
- higher dryness into press improved water handling and felt performance

Total annual value of over $135,000 in energy savings.

Tissue Grades

Location: North America
Former: C-wrap former, Outer position
Grade: 100% recycled
Speed: 5,720 FPM
Problem: Customer needed improved sheet formation, drainage, and to maintain or improve fabric life.
Result: Replaced existing fabric with Formsoft on outer position.

- significant improvement in sheet formation leading to reduction in sheet rejects
- reduced sheet breaks
- increase fabric life

Total annual value of over $300,000.

Packaging Grades

Location: North America
Former: Fourdrinier
Grade: Liner
Speed: 1,800 FPM
Previous Fabrics: SSB
Problem: Customer experiencing high break rate, low couch dryness.
Result: Replaced existing SSB fabric with HTX V2.

- immediate reduction in sheet breaks by almost 50%
- increased off-couch dryness by almost 2% points
- nearly 1.2% increase in average speeds over the entire grade spectrum

Total annual value of almost $700,000.

CONCLUSION

The development of technologically advanced forming fabrics has progressed to unforeseen levels. Field proven fabrics are now commercially available to make not only higher quality sheets, but at reduced operating costs.

From our decades-old synthetic "wire" which changed the industry forever, to today's state-of-the-art designs incorporating innovative structures with space-age raw materials, customers can operate their machines at higher speeds, using less energy per ton of production and with increased confidence in the durability of their forming fabrics.

This is especially significant to the papermaker as these new fabric technologies often deliver operational savings many times greater than their acquisition costs. ■

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