

JUNE 1998

PaperAge



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Tri-axial Fiber Support Fabrics For Brown Paper Forming

Customer demand for high quality, low cost, environmentally friendly packaging has raised the bar significantly for the brown paper producer. The need for high performance grades has accelerated technology changes, and economic considerations have required increased compression strength while reducing basis weight. Today's high strength to weight packaging grades are up to 20% lighter in basis weight than the 1980's equivalents.

Changes in papermaking technology have altered both the machine and the furnish. The greatest impacts on pulp furnish have been the use of hardwoods and the incorporation of recycled fiber content ranging from 20% high quality secondary fiber to the dreaded 100% OCC, which may actually be more curbside waste than old corrugated containers. However, linerboard produced from 100% waste is no longer viewed as an inferior product.

The biggest changes to machines have been the addition of top wire dewatering units and mini-fourdriniers to produce two, three, and more ply sheets faster than the traditional fourdrinier and secondary headbox or multi-cylinder machine of years past. The improvements in headbox technology have also allowed for reduction in cross machine moisture profile and basis weight variation. With the advent of the latest technology in multi-ply

forming, different qualities of fiber can be interspersed in the various plies to provide strength, inexpensive filling, or high quality surface finish for graphic display as required.

In today's market place, not only must the packaging contain and protect the product during transport but also it must appeal to the end user of the jogging shoe, computer program, or even the color television. In some instances it may seem that the package is more important to catching the purchaser's attention than the product inside. White top, Clay Coated and Mottled Board grades can successfully compete against more expensive SBS in some applications using today's changes in printing methods. Even unbleached linerboard can have smoother surface requirements for improved printing quality.

The Challenge to the Clothing Manufacturer

The machines and headboxes can deliver the necessary furnish and, if need be, the individual ply separation needed to create today's packaging materials, but they cannot deliver the enhanced properties without help from the forming fabric. The majority of forming fabrics in use today are designed predominantly for long life and cleanability by using large CMD yarns and coarse meshes. This impacts the cost of manufacture of paper to a very small degree, but has

little effect on the majority of critical packaging industry issues we've described. In fact, some of the efforts that are made to increase life can be counter-productive to the strength to weight ratio and surface finish properties.

The advent of gap forming has brought new awareness to forming, especially in making products that require uniform fine fiber distribution and control of hydraulic forces to improve formation and resist flow marking. With a gap former, the headbox extrudes the sheet at higher rush/drag ratios and the twin wire configuration puts significantly more pressure on the center of the forming fabric. Within 0.3 seconds at 2400 FPM, the sheet has reached the same consistency that it would require 1.2 seconds to achieve on a conventional linerboard machine. Because of this more rigorous drainage, forming fabric flow marks will be more evident, retention will be reduced in the surface plies, and fabric stability will be tested to the limits.

Because these issues are counter-productive to meeting the customer demand for high quality, low cost, environmentally friendly packaging materials, the fabric designer was challenged to figure out the compromises

that would provide the least negative impact on finished board properties. The major forming fabric variables to providing the best operational and test properties are fiber support, drainage path control, and fabric strength and rigidity. Generally speaking, it's fairly simple for the designer to increase fiber support, just add more, slightly smaller yarns to the fabric to increase the number of support points and reduce the grid length.

As with all simple relationships, its just not that simple. Due to the high drag loads generated in brown paper forming, machine direction and cross direction yarns must be large diameter to resist stretching, buckling and wear. But, the large volumes of water that must be moved require relatively large drainage holes. Hence, the addition of even a few more yarns of diameter sufficient to resist the demanding physical forces reduces drainage too much. The challenge for the fabric designer was to develop a superior fiber support surface with enough openness to provide high, effective drainage, while maintaining a durable, rigid, wear-resistant machine contacting side on a stretch resistant fabric platform.

Development of the Tri-axial Fiber Support Fabric

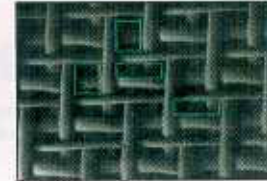
In typical multi-layer structures, the top cross machine yarns are segregated to keep large diameter yarns on the bottom and fine diameter yarns on the top. Standard 2½ layer or X-weave products in some cases, lack the guts (rigidity) to stand up to high flow. Because the interlacing or base pick yarn undulates in the structure while passing under long MD floats, they are more prone to yarn movement. In the 3-layer fabrics, the plain weave topside pattern locks the CD yarns from moving, but creates large surface holes. Neither of these optimizes the fabric to solve today's critical machine operation issues.

Fiber Support Frames

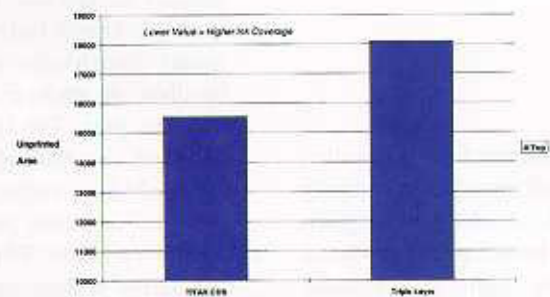
Titan CDS



Standard 2-1/2 Layer



Linerboard Printability Analysis Ink Coverage



Marking Tendency

Fabric Knuckle Mark



TITAN-CDS



Triple Layer

As described in U.S. Patent 5,641,001, Wilson envisioned the solution to this dilemma as a more rigorous 2-layer fabric containing additional yarns located in saddles so that they cross the fiber support grid on a diagonal. The two distinct advantages to this structure are that the smaller yarns force the larger surface yarns to stay straight in the fabric and resist undulation, thus providing a flat, rigid fabric. In addition, the typical 2½ layer has distinct diagonal flow patterns directly related to the same long MD surface floats that allowed the base picks to move. By creating saddles, the MD floats are reduced in length, minimizing this marking characteristic. Thus, the locating of yarns in saddles creates a natural tendency for tri-axial fiber support versus the bi-axial surfaces of today. This forms a unique triangular shaped frame support grid unlike the typical rectangular shapes described and modeled by Beran in his fiber support index calculation⁽¹⁾.

Tri-axial Support Fabrics Provide Results

The TITAN-CDS fabric from Weavexx provides very high CMD and cross x, y axis fiber support for the predominantly machine direction oriented fibers coming out of the headbox. The unique tri-axial support system insures that the sheet is formed up on the forming fabric surface resulting in micro-density uniformity, high retention, and outstanding sheet release. Practical experience has shown that this translates to increases of 3-5% in strength-to-weight ratio and better print performance.

At Weavexx, we have also developed a unique printability tester that can quickly make print comparisons. Using this equipment, we have been able to document printability improvement using the TITAN-CDS. For instance, one of the benefits noted is increased ink coverage on the printable (top)

side of linerboard made by twin wire or top-wire forming.

In addition to improved printability and test, several papermakers have commented on the stability provided by the tri-axial bridging of the structure. Many are quick to note the flatness and resistance to distortion or skewing that has provided improved profile properties in board and medium production. Finally, because the fabric provides high retention and outstanding sheet release, more of the fiber and contaminants stay in the sheet and less embed in the fabric making it easier to clean and maintain.

Clearly, when it comes to meeting the demands of manufacturing today's packaging materials, the tri-axial support forming fabric accomplishes those goals. The patented TITAN-CDS is helping brown papermakers realize these stringent requirements on fourdriniers, top-wire formers, and multi-fourdriniers at mill sites in the United States, Canada and Mexico.

References:

- (1) Beran, R.L., "The Evaluation and Selection of Forming Fabrics," TAPPI Journal, Vol. 62, No. 4, 1979.

