TECHNICAL BULLETIN

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TRI 1001

AIR JET SPINNING OF COTTON YARNS

INTRODUCTION

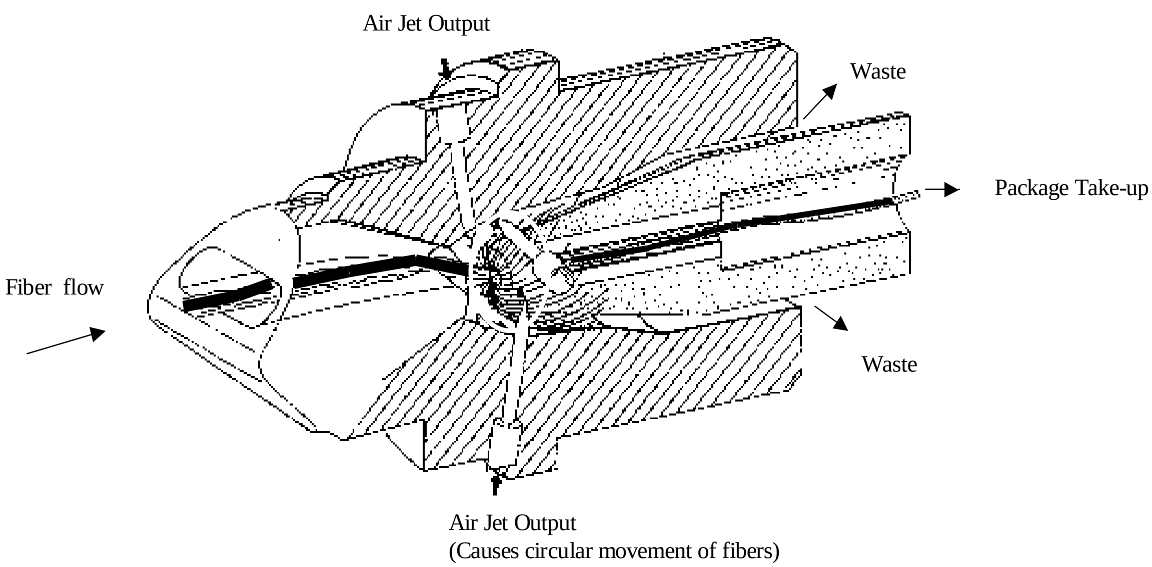
Since its introduction in 1980, air jet spinning has offered yarn manufacturers the opportunity to produce yarn at relatively high production rates. Some of the obstacles for the earlier generations of air jet machinery included difficulty to make 100% cotton yarns and the generally harsh hand of the fabrics produced from them. Starting with the first air jet spinning machine, Cotton Incorporated, in close cooperation with Murata, worked extensively to develop a working knowledge of the fiber selection parameters and preparation procedures necessary to produce 100% cotton and cotton-rich air jet yarns. Machine design changes, based on Cotton Incorporated's research, affected the evolution of air jet spinning from the early Murata Jet Spinners (MJS) to the recently developed Murata Vortex Spinner (MVS). Because the MJS machine remains largely a cotton blend and 100% synthetic spinning technology, the focus of this technical bulletin is exclusive to the MVS technology.

Unlike other spinning methods in which productivity is limited by the amount of twist in the yarn, air jet yarns, in general, can be produced at the same production rate regardless of yarn counts. MVS machines excel at producing finer yarns (Ne 40/1-60/1), because of the improved strength imparted to the smaller fiber bundle. MVS technology is not suitable for spinning yarn counts coarser than Ne 12/1. Compared to ring yarns made from the same fiber properties, the primary drawback of yarns produced by the MVS system relates primarily to their lower tenacity. It is also important to note that the MVS system removes significant amounts of short fiber during the spinning process. Waste percentages typically range from 3-8%, depending on whether combed or carded cotton is being used. The removal of short fiber improves the yarn's total imperfections and resultant fabric appearance/sheen. In addition, with new components available from Murata, MVS yarns can be made with varying levels of hairiness that can directly influence the fabric's hand/softness while maintaining excellent resistance to pilling and abrasion.

MVS SPINNING CONCEPT

The vortex design represents a radical departure from the basic MJS design. This new and innovative design differs from its predecessor almost entirely in the air jet (or vortex) area itself. These changes facilitate an improved preservation of fiber alignment/orientation and a more efficient transfer of the air vortex's energy into an actual twisting action on the fiber bundle (see Figure 1). As a result of these innovations, the system makes more efficient use of fiber length and provides an improved yarn structure. These improvements are largely responsible for this machine's ability to spin 100% cotton.

Figure 1. Murata Vortex Spinning Components
(Courtesy of Muratec)



For the same reasons that these design changes have impacted spinning, they have also influenced the resulting yarn qualities and important fabric characteristics. Yarns are smoother to the touch because of the absence of "wrapper" fibers and improved fiber alignment. These same aspects are also responsible for improved fabric appearance and fabric "hand" when compared to previous MJS results.

FIBER SELECTION FOR MVS YARNS

The fiber selection for the MVS system should be approached in the same manner as ring spinning. The laydown properties must be selected in accordance with the desired quality of the end product.

Fiber Length

The MVS drafting mechanism incorporates roller drafting as a means of reducing/controlling the number of fibers in the cross section of the resultant yarn. Previous studies show that overall fiber length and short fiber content (SFC%) in the laydown play significant roles in obtaining desired yarn properties. In general, the MVS system requires medium to long fibers in the laydown. The MVS cotton laydown should be more similar to a ring-spun laydown than an open-end (OE) laydown.

Short Fiber Content

An inherent trait of MVS is the removal of short fibers during spinning. A higher SFC% in the virgin cotton lint or the introduction of waste into the laydown negatively affects yarn quality and the amount of waste removed during spinning. Yarn count range and yarn strength are also influenced by the amount of SFC% in the sliver.

Micronaire

Spinning trials indicate that decreases in fiber fineness or increases in micronaire can limit count range and spinning performance in the same way as it might on ring spinning.

Trash Content

Cotton should be clean and absent of seed coat fragments. The presence of trash has a negative effect on spinning performance. Seed coat fragments can collect on top and bottom drafting rolls, which can cause lapping and ends down. Furthermore, trash and seed coat neps can cause choke in the spindle also leading to ends down. At the high surface velocities normal for this spinning system, any lapping or fiber chokes can quickly damage spinning components.

Fiber Tenacity

Fiber tenacity is another important parameter, because it is directly related to the resultant yarn and fabric strength.

FIBER PROCESSING PARAMETERS

Fiber processing parameters should be chosen to protect the fiber from breakage and over-working. This ensures that the finisher sliver is uniform and consists of highly parallel fibers and a low short fiber content.

Opening and Cleaning

The opening action must be as gentle as possible to avoid excessive breakage of fibers. The raw cotton stock should be opened into the smallest possible tufts to ensure thorough blending action and good cleaning efficiency. Do not exceed manufacturer’s recommendations for throughput and maintain an 85-90% material run time on all machines in the blow room.

Carding

Carding is the most important phase in the entire production process. Settings, wire condition, waste removal, and nep extraction dictate the resultant spinning performance and yarn quality. Visible foreign matter and nep content should be monitored for each card in the mill not just as a room average.

Drawing

Previous drawing trials indicate that three processes of drawing tend to attain maximum fiber alignment and provide for the best yarn quality for carded cotton. Only one process of drawing after combing is recommended for combed yarns. The sliver weight is determined by the yarn count being spun.

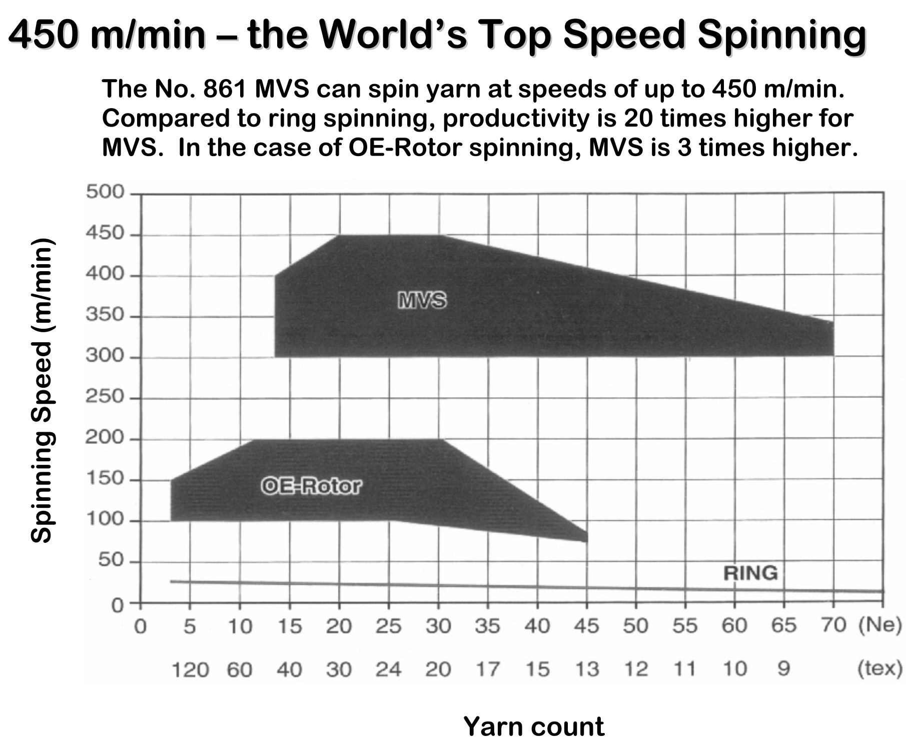
Combing

Combing the carded cotton allows for finer yarn counts to be spun. Reduction of SFC% reduces waste at spinning, improves yarn tensile and evenness characteristics, and enhances fabric appearance and drape. Spinning performance may also improve with combed fiber.

MURATA VORTEX SPINNING

Like any other spinning system, the MVS performs best with properly prepared fiber. The cotton fibers should be parallel and free of extraneous matter. The MVS Model 851 machine can reach speeds of up to 400 meters/minute. New piecing and clearer technology and tension control may allow future models to exceed production rates of 450-500 meters/minute (see Figure 2).

Figure 2. Spinning System Production Rate Comparison
(Courtesy of Muratec)

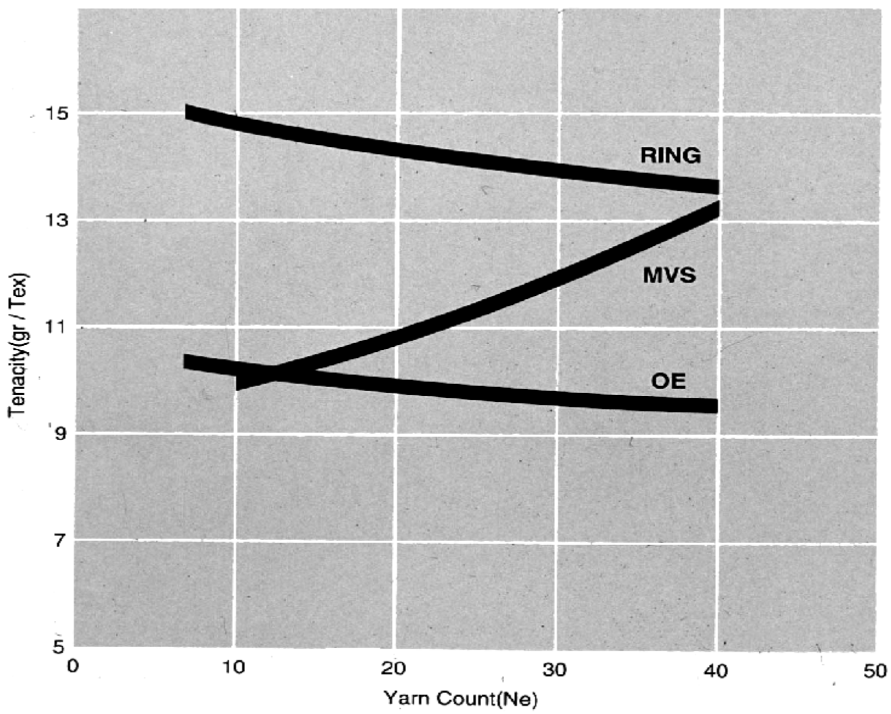


Cotton Incorporated conducted extensive research on the MVS Model 851 spinning frame installed in the Fiber Processing Laboratory in Cary, NC. Controlled comparison studies (Murata Vortex Spinning Comparison – Report Number 1999-1) were conducted in the late 1990s, which clearly show the quality relationships among MVS, ring, and rotor-spun yarns and the resultant knit and woven fabrics. MVS yarn strength improved as yarn count became finer (see general strength trend in Chart I).

Chart I: Tenacity of MVS Yarn In Relation to Yarn Count

Strength Trend (gram/Tex) vs. Yarn Count (Ne)

(Courtesy of Muratec)



The overall yarn evenness is equal to ring and rotor yarns. Total imperfections (thin places, thick places, and neps) are generally lower than ring and rotor yarns, especially for finer yarn counts. The knit fabrics made from MVS yarns had better overall surface definition, especially compared to ring yarns. The MVS knit fabrics exhibited better surface appearance after repeated launderings. There was slightly less torque or skew with the MVS fabrics compared to ring-spun fabrics.

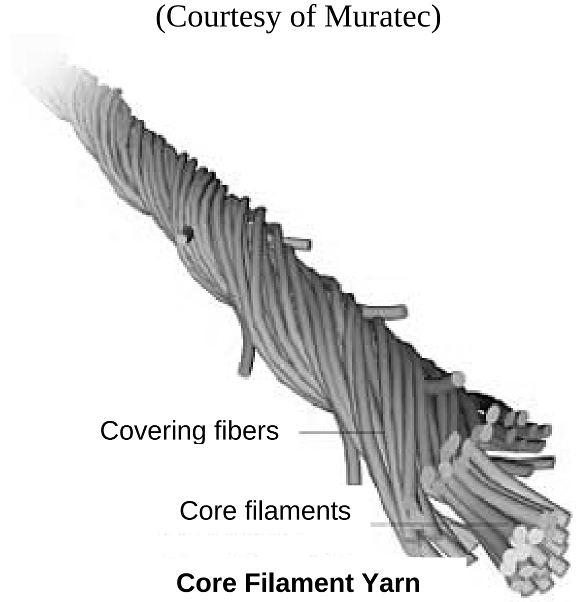
<u>Soft Hand MVS Technology</u>

Historically, fabrics made from air jet yarns have a harsher hand when compared to ring and rotor spinning systems. Recent developments at Cotton Incorporated led to breakthrough results with respect to this important aspect. Through proper raw material selection, component selection, and machinery settings, "soft" MVS yarns are attainable and well suited for knit end uses. Soft hand developments performed at Cotton Incorporated, comparing ring and MVS spun fabrics made from the same cotton laydown, showed indistinguishable differences with respect to resultant fabric softness. In addition, the appearance and pilling/abrasion resistance is as good as if not better than the MVS fabrics, especially after multiple home launderings and tumble dryings.

Core Spinning Technology

The MVS spinning frame has core-spinning capability. This is a process in which a filament or staple yarn is fed behind the front roll of the drafting system and covered (or wrapped) with another fiber during the spinning process. Figure 3 shows the composition of a core spun yarn.

Figure 3. Core Spun MVS Yarn
(Courtesy of Muratec)



MVS technology is ideal for this type of end use, mainly because of the wrapping effect imparted at the spindle. The fibers are literally wrapped around the self-centering core component. A key advantage of MVS core spun technology compared to ring core-spun technology is that the core is not twisted during spinning. As a result, fabric torque is reduced in MVS core spun fabrics.

Novelty Yarns

Splash yarn is a novelty yarn, which can be easily made by supplying colored yarns to each part of a draft. Thanks to the unique formation method, colored yarn is scattered through the yarn, giving the spinner the possibility of creating value-added yarns. The combinations and types have infinite potential.

Future developments could include mechanical slub attachments, twin spinning (two parallel yarns on same package), and specialized spinning components.

Conclusion

Since its official introduction in 1997, the MVS system has developed into a viable choice for many end uses. The production rate and yarn characteristics of MVS yarns continue to create interest among those in the spinning and fabric formation sectors.

The spinning technology continues to evolve. Cotton Incorporated possesses intimate knowledge of the capabilities of the MVS technology. The Fiber Processing Research group will continue to develop and implement MVS project work that addresses the needs of U.S. cotton consumers.

RESEARCH AND TECHNICAL SERVICES

Cotton Incorporated is a research and promotion company representing cotton worldwide. Through research and technical services, our company has the capability to develop, evaluate, and then commercialize the latest technology to benefit cotton.

- Agricultural research leads to improved agronomic practices, pest control and fiber variants with properties required by the most modern textile processes and consumer preferences. Ginning development provides efficient and effective machines for preservation of fiber characteristics. Cottonseed value is enhanced with biotechnology research to improve nutritional qualities and expand the animal food market.

- Research in fiber quality leads to improved fiber testing methodology and seasonal fiber analyses to bring better value both to growers and then mill customers.

- Computerized fiber management techniques result from in-depth fiber processing research.

- Product Development and Implementation operates programs leading to the commercialization of new finishes and improved energy and water conserving dyeing and finishing systems. New cotton fabrics are engineered -- wovens, circular knits, warp knits, and nonwovens -- that meet today's standards for performance.

- Technology Implementation provides comprehensive and customized professional assistance to the cotton industry and its customers -- textile mills and manufacturers.

- A fiber to yarn pilot spinning center allows full exploration of alternative methods of producing yarn for various products from cotton with specific fiber profiles.

- The Company operates its own dyeing and finishing laboratory, knitting laboratory, and a laboratory for physical testing of yarn, fabric, and fiber properties including High Volume Instrument testing capable of measuring micronaire, staple length, strength, uniformity, color, and trash content.

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