

GENERAL TIPS OF WHAT LITTLE THE FIRST AUTHOR HAS LEARNED ABOUT COTTON PROCESSING IN TRADITIONAL TEXTILE MANUFACTURING

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This article, under the following sub-headings, briefly describes a few important tips that mainly the first author has learned in his career involving processing of cotton in traditional textile manufacturing:

1. Bale Selection and Fiber Mixing

Although Cotton Incorporated's HVI-data-based, EFSR cotton bale management system is ideal for efficient processing of cotton and, consequently, for greater profitability of a cotton textile plant, some plants still follow the age-old practice of mixing a few (up to 4) bales of discounted (off-quality, recycled, processed and/or even waste) cotton per 100 bales of regular (classic/virgin) cotton, in order to reduce the average cost of the raw material, which undoubtedly is the major cost factor or component of any cotton yarn or fabric produced. However, the author's mill experience has revealed that the overall, true productivity and hence the profitability of an integrated cotton textile mill also depends greatly on the following factors, which must be optimized for each specific process and its metrics in any fiber-to-fabric conversion:

- process/machine production speed
- ambient atmospheric conditions
- actual production efficiency
- waste generated
- labor endurance (toil threshold)
- quality and goodwill of the end-product (repeat business).
- environmental impact,
- ultimate satisfaction of the consumer at large.

2. Fiber Opening and Cleaning

If "line choking" occurs even once a day, please pay close attention to its possible cause(s), including the aerodynamics, and remedy the situation without fail. Although the cotton opening and cleaning processes are well known for causing fiber damage/breakage, every mill must determine its own acceptable level of the damage, i.e., the short fiber (<1/2 inch) content of the carded stock. A certain amount of short fibers in a certain fiber population for a certain end-product may not be as detrimental as the lack of proper opening and cleaning and the subsequent adverse impact, overall. For a typical upland cotton variety, at least three pieces/points of cleaning equipment are recommended -- the third being a fine opener/cleaner (preferably, a saw-tooth type). Again, the equipment settings and the production speed, efficiency and quality must be appropriately optimized for maximum returns. Each textile mill apparently has its own unique features, which must be intelligently balanced. Occasional measurements and analyses of the dust and wastes collected at each point and the proper settings of "grid bars" frequently pay good dividends.

3. Carding

In reality, a card is the cotton cleaning machine that also performs three additional functions, viz., aligning and parallelizing the fibers, somewhat creating as well as removing fiber hooks and extremely short fibers, and finally condensing the fibers into a web or a sliver of certain linear density for down-stream processes. In order to achieve the optimum output from a card, it must be properly set up to accommodate/process the specific cotton stock for a specific end-product. Settings of the feed plate/roll to the licker-in, the licker-in to the cylinder, the cylinder to the flats and the doffer are all critical for optimization of the carding process for a specific fiber stock and for the desired product quality, while always keeping in mind the "cost-value" aspect of the process. Regular maintenance of the card, especially sharpening of the wires, checking of the licker-in saw teeth, and proper (air) pneumatic controls are critical for optimum performance of a card. Regarding the card's production speed, the jury is still out. There are card masters who prefer to run their

cotton cards at ~ 100 pounds per hour, while there are mills which are successfully running their cards at 500 pounds per hour. Again, all the cost-value factors stated previously must be considered in determining the optimum carding production rate.

4. Drawing

An auto-leveler is a must for a modern draw frame to control the output sliver's linear density. However, if the production speed exceeds a certain limit for certain stock and for certain conditions, its effectiveness may be considerably compromised. Again, trials with different production speeds should be conducted to determine the most effective rate of production. Also, this reporter still believes in at least two draw frame passages for better sliver uniformity, which goes a long way in improving the subsequent, costly processes, especially spinning, weaving and knitting. Proper roller settings and weightings for a particular cotton quality are also very important.

5. Combing (if necessary)

The fiber characteristics/quality of the input material (comber laps) and the desired characteristics of the output material (sliver) actually determine the comber settings. A minimum 12% removal of noils is essential to attain optimum cost-value effectiveness from a combing operation. Since the combing mainly is for fine and super fine yarn counts (>40 Ne), it is not as prevalent in the US as it is in the East.

6. Roving

Keep as low roving twist level and hence the roving tension as efficiently possible. This will increase the roving productivity and also yield a rich dividend in ring spinning.

7. Spinning:

Ring:

Low back-rollers' draft low twist, small ring diameter, small lift (bobbin length) for optimum yarn strength and uniformity. Remember, the uniformity of yarn characteristics is more critical in the downstream processes and end-use than the average or absolute values of the characteristics. Yarn hairiness, if critical, can be controlled by manipulating spinning parameters, especially the yarn twist level, spinning tension, traveler profile, and balloon control. If the traveler burn is excessive, it is worthwhile to slightly reduce spinning tension. The traditional traveler surface speed of a "mile a minute" can now be surpassed with due care of the various elements involved. Theoretically, if the roving quality is good and the spinning parameters are set correctly, the ends down rate should be negligible and, hence, the yarn quality, the productivity of downstream processes (specially the warp sizing and weaving), and the quality of end-product will be improved.

Rotor:

Frankly, instead of the "ring spinning," the rotor spinning," despite some of its yarn weakness, should indeed be termed as the "workhorse" of the cotton spinning industry today. From coarse to medium- high count yarns, the open-end/rotor spinning gives the overall best returns. The yarn, although it is slightly weaker and more twist lively than an equivalent ring spun yarn, is more uniform, less hairy, and bulkier than a comparable ring spun yarn. The yarn's improved uniformity alone offsets any of its deficiencies in the downstream processes, including weaving. Cleanliness of the input cotton stock/sliver is the key to achieve the best possible performance in rotor spinning. A little extra care in the cotton opening, cleaning and carding will yield high productivity and quality of the rotor yarn produced. Of course, the optimum settings and selections of the various components involved in rotor spinning are also as critical as in any other manufacturing process. Optimization of yarn twist level to minimize twist liveliness is a step in the right direction, as well.

Air jet/Vortex (Murata, Japan)

...Although the vortex spinning system has not been popular in the US, it really is an excellent technology for efficiently producing fine (40's and higher) cotton yarn counts. The yarn is extremely uniform in all of its important characteristics, such as tensile strength and evenness. The defect rate, especially that of major defects, is remarkably low. The yarn strength and tenacity may be a bit lower than those of a comparable ring spun yarn, its normalized performance in knitting and weaving processes may in fact be better. Like a rotor-spun yarn, a vortex-spun cotton yarn is slightly harsher than an equivalent ring-spun yarn, and,

therefore, appropriate care should be taken to offset or compensate this particular yarn characteristic by manipulating the process metrics as well as by exploring special fabric finishes to permanently soften the fabric hand.

Friction (Dref, Austria)

Friction spinning is a good technology mainly for producing coarse to medium count yarns for technical and industrial fabrics and their composites. However, the friction spinning technology may not be ideal especially for spinning run-of-the-mill cotton yarns for classical fabrics for popular apparel. The other spinning technologies mentioned above, coupled with doubling or any other strength-reinforcing process, may yield a better bottom line. A major drawback of friction spinning lies in its energy and floor (space) consumptions. The yarn quality, compared to the traditional cotton textile standards may also be marginal. Still, for certain coarse count applications for certain high-volume technical, geo, industrial and military end-uses, the friction spinning system may be the only viable option available.

8. Winding

Although the yarn winding is a relatively simple process, it certainly is critical in the overall fabric manufacturing chain. Precautions must be taken to ensure uniform and consistent winding tension throughout the wound package. Tension variations among individual strands of a set of yarns (e.g., a warp creel for weaving, a loom beam, a knitting creel, etc.) can play havoc with regard to the productivity and quality in the fabric formation process. Several precision types of yarn tension control devices are now available, which do a superb job of keeping yarn winding tension uniform and consistent from the beginning to the end of package. It may be noted that the tension variations within a supply package and among different supply packages of the input yarn may also influence the winding tension of the output yarn on a winding machine. Hence, it is advisable to ensure uniform tension of the input yarn, as well. If a wax/lubricant must be applied to a yarn during winding, ensure that the yarn sensors are calibrated with the treated yarn, as intended since most of these yarn sensors are based on the capacitance/condenser principle. Overlapping of yarn layers and the resultant edge distortion is a serious problem, but it can be easily controlled by regularly examining and maintaining the grooved cams, the yarn guides, driving belts and gears, and the ambient atmospheric conditions.

9. Warping

The key in warping operation is to maintain consistent yarn withdrawal tension by checking the yarn tension devices (dead weights, spring torque, etc.) throughout the creel and to be able to brake/stop the machine (drum) instantly (or, within one rotation of the drum), so that any broken yarn strand can be easily located and mended on the warp beam. It is human nature to simply ignore a task or a problem that is too frequent and difficult to resolve. If the operator cannot easily and comfortably locate a broken end on the beam, she or he obviously will soon get tired beyond her/his endurance and will develop a bad habit of letting the broken end go w/o being properly mended. This, in turn, will interrupt production and quality in the following slashing operation, while causing a potential risk of idling thousands of ends (yarn strands) during a likely loom stoppage.

10. Slashing

Warp sizing/slashing is a very costly, laborious, time-consuming, and environment-sensitive process, but it also is the backbone of any cotton weaving operation. The important tips for sizing/slashing are: Minimize, if you can't eliminate, "creeping speeds;" spend due time and effort in properly preparing the set, i.e., use back and front combs and lease rods; eliminate any yarn crossing; always prepare, maintain and store, if necessary, size mix according to well established procedures and recipes for specific fabric styles; set conditions to maintain at least 6% moisture regain in the slashed warp. Never let the warp over or under dry. Avoid creeping or stopping the slasher for lunch breaks or any other reasonably avoidable reason. Slashing over 100 yards a minute diminishes the operation's overall effectiveness for a set of cotton yarns. Last, but not least, avoid use of wax or any other lubricant to coat the yarn. Although the application of a very thin coat (<0.1% by wt.) of a paraffin wax or some other lubricant may assist weaving, it sometimes can cause great difficulties in certain dyeing and special finishing.

11. Weaving

Today's weaving machines are considerably more productive and labor friendly, compared to those of just a decade ago. Modern weaving machines are almost totally automatic with several built-in self-diagnostic and self-performing features. Obviously, a stoppage of such an efficient and productive machine is proportionately much costlier than a similar stoppage of an older version (of just 10 years ago) weaving machine. Hence, it is critical that everything humanly possible is done to ensure almost zero stoppage per hour. And there indeed are numerous things, however out of the scope of this article that can be done to achieve almost 100% efficiency on these first-class machines that are mostly made in Europe and Japan.

Some of the critical tips include the best possible fiber and yarn qualities, warp and filling preparations, proper machine maintenance (especially the filling insertion system), optimum ambient atmospheric conditions with a minimum of 80% RH and 75 F for a 100% cotton processing operation, sufficient lighting arrangement, and appropriate work load for the weaver (based on not more than 30 machine stoppages per hour). Any machine causing repetitive stoppages of any particular kind must be thoroughly examined and certified by a well qualified supervisor. Otherwise, the poor weaver would have no choice but ruin productivity of her/his entire section. Occasionally, a slight, undetectable change in the fabric structure (normally the pick density), coupled with a slight reduction in production speed can yield unimaginable productivity gain in certain circumstances and under certain conditions.

12. Fabric Finishing (outside the scope of this article)**13. Testing & QC (throughout the above fiber-to-fabric processes)**

Last, but not least, it is imperative that a practically viable (online or off line) testing and quality control program is instituted throughout the above-listed production chain and religiously enforced to regularly monitor and control the in-process material quality and the process performance/efficiency in a timely manner. Otherwise, even a relatively minor problem may become a serious one, which can adversely impact the financial bottom line of the operation. The following practices, tests and/or controls are critical: selection and mixing of cotton bales to achieve desired homogeneity of the raw stock; periodic measurements of the quantities and profiles of the wastes generated at the cotton opening and cleaning points; card pneumatics and wastes (licker-in, cylinder, flats, etc.); leaf settings of the card (especially between the cylinder wires and the flat wires); conditions of the various wires and saw teeth (regular sharpening/ maintenance of the wires); periodic inspection of the card web, using black boards, for specks, neps and any other prominent defect; uniformity/evenness of the card sliver's linear density and Uster CV, etc.; number of failures/piecing occurring in unit time period; uniformity (linear density and CV) of the last drawn sliver; the roving uniformity and actual-twist level; ends down in spinning and their precise causes; the yarn's count variation, uniformity/CV, comparative appearance grade, breaking strength and elongation, defects (major and minor classification), and package profile and density (sometimes, it is advisable not to piece a broken end and instead start producing a new yarn package to avoid piecing time and defect – generally, an auto machine knot in spinning or during winding may be a better bet than a yarn piecing); yarn winding statistics; warping statistics; slasher bottlenecks, beam density, moisture content, actual size add-on, yarn stretch (should not exceed 1%), proper wrapping and transportation of the sized/loom beam enroute to drawing room/weave room; warp knotting efficiency and creation of any crossed ends; cautious beam mounting onto a weaving machine; a thorough and timely evaluation of the first good yard woven to ensure compliance with the required specifications; records and intelligent analyses and resolutions of all types production failures, including the warp and filling yarns' failures and the machine failures; the weaver's workload assessment (very important); weaver's efficiency, machine efficiency, and overall weaving efficiency; fabric defects and their classification and remedies; and %age of second-quality fabric rolls and their predominant causes (fabric width and weight, selvage defects, oil stains, tears, floats of broken yarns, and the like).