

Future Spinning Technology: Compact Spinning

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In the past a number of new spinning technologies have been introduced to compete with ring spinning. While the air-jet spinning and friction spinning both have applications in specific markets, the open-end rotor system eliminating roving, winding has been very successful and has grabbed a considerable share of the short-staple cotton spinning market, as this system has been able to achieve tremendous increase in the production against Ring Spinning.

Though this system's productivity is higher when compared to other systems, other quality parameters limit commercial applications of its yarn only to the coarse counts. Among all technologies, conventional ring spinning remains uncontested on quality standards and continues to dominate the high value added yarn markets. During the last two decades, components of ring spinning machines have been greatly improved and changes in drafting system, drive systems and robotics have enabled large gains in productivity, flexibility and quality. Most of the technical advances in ring spinning were aimed at improving the performances on the existing technology. In recent years, however a bonafied innovation has occurred. It is called compact or condensed spinning, because it minimizes width and height of the spinning triangle associated with ring spinning. Several experts have described the technical principles of compact spinning that results in a more organized structure without peripheral fibers and with a better twist distribution. As a result of this enhanced structure, it has been shown to effectively improve yarn quality and its performance during downstream processing.

With the introduction of "Compact Ring Spinning" in late 1990s, the situation in ring spinning has changed fundamentally, in all relevant quality criteria. Genuine condensed or compact yarns are substantially superior to conventional ring yarn to such a degree that it is no longer possible to speak of a standard market value. This is a revolution in ring spinning and one can categorically say that the future belongs to compact yarns. Compact spinning technique can be used universally for all raw materials, blends as well as for the complete count range without restriction. In compact spinning the spinning triangle associated with conventional ring spinning is eliminated by pneumatic compaction which happens by suction and compaction on a perforated revolving drum/ apron in the front zone of the drafting system. The process is characterized by the introduction of a fourth nip point down stream of the exit form the conventional 3/3 drafting system which acts as an aerodynamic condenser. The aerodynamic condensing of the fibers through suction results in narrower spinning zone, with individuals fibers more effectively bound into the yarn assembly. It has the potential to create a near perfect yarn structure by applying air suction to condense the fiber stream in the main drafting zone, therefore virtually eliminating the spinning triangle.

In conventional spinning a spinning triangle is formed immediately after the drafting mechanism in the Ring Frame. The spinning triangle is a weak zone due to less twist in this region; under normal working conditions most of the breaks occur near-vicinity of the spinning triangle. The strength of the fibrous mass in the spinning triangle determines the attainable spindle speed. Hence, if the spinning triangle is avoided or its length reduced, the achievable spindle speed would be increased. Compact spinning technology has potential for improving both the quality and profitability aspects of cotton yarn manufacturing. Depending on the objectives of the textile manufacture, different approaches are available. One approach could be to reduce the cost of the raw material, while maintaining quality. Another could be reducing twist, while using the some raw

material. Yet another is to eliminate some or all of the combing, while still producing acceptable yarn quality.

Compact spun yarn has better abrasion resistance. Fabric properties in terms of breaking strength, breaking elongation and tear strength are also better with compact yarn. Table showing the comparison of yarn properties of compact yarn and normal spun yarn are given below:

Benchmarking of compact yarn with conventional ring spun yarn

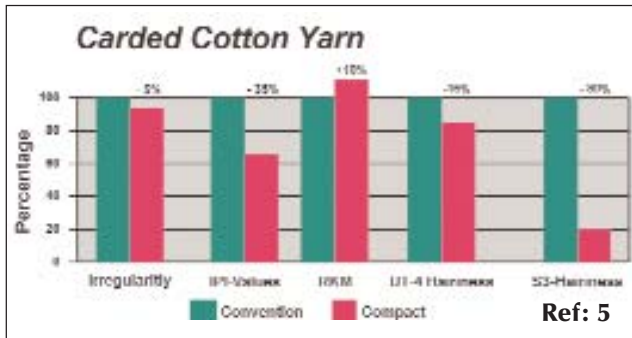
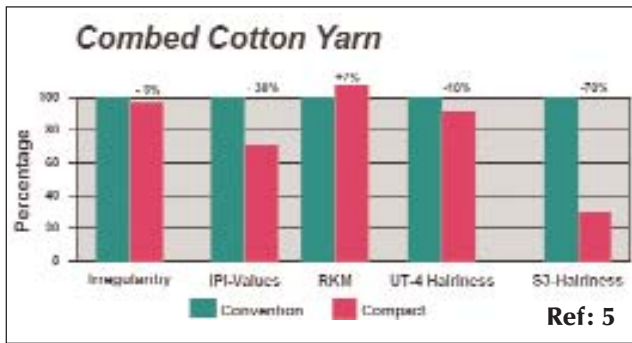
Following charts benchmark select properties of both combed and carded cotton yarns spun on compact spinning system and conventional ring spinning system. In carded/combed for fine counts,

Cotton used				
Item	Compact	Normal		Normal
	Punjab (100%)	CIS (50%)	Punjab (50%)	Punjab (100%)
Length (mm)	27.8	29.8	27.8	27.8
Micronaire	4.5	4.40	4.50	4.5
Strength	88	95	88	88
Comber Noil%	16.5	18.5		20.0

Bales lay down according to Uster Technologies AG & EFS System.

Cone Yarn Test Results					
Item	Compact 1	Normal 2	Normal 3	1%	1%
Material (Cotton)	100% (Punjab)	50% CIS+ 50% (Punjab)	100% (Punjab)	1% w.r.t. 2	1% w.r.t. 3
Count (Ne)	40.00	40.00	40.00		
Count CV%	1.796	2.310	1.926		
Strength (lbs)	69.20	60.00	56.25		
Strength CV%	5.43	5.27	4.52		
LCSP	2768	2400	2228		
U%	10.66	11.57	11.84	7.8	10.0
Thin (-50%)	3.5	22.5	30.4		
Thick (+50%)	31.3	98.3	87.9		
Neps (+200%)	91.3	138.1	93.8		
IPI	126.1	258.9	212.1	51.3	44.8
Hairiness	4.6	5.37	5.51	14.3	16.5
B-Force	256.9	222.2	197.8		
B-Force CV%	11.25	8.35	16.93		
Tenacity Gms/Tex	16.73	15.06	13.4	11.1	19.9
Tenacity CV%	11.25	8.35	16.93		
Elongation	4.51	4.41	3.55		
Elongation CV%	11.33	11.57	14.25		
A1+B1+C1+D2	396.6	212.5	114.4		
A3+B3+C2+D3	20.8	5.7	4.8		
H2	0	3.4	1.6		
12	0	2.5	2.4		
Spindle RPM	21.000	19,300	18.300		
TPI	25.15	27.96	28.78		
Production -OPS	5.1	4.2	3.9		

Abbreviation: ↑ Improvement W.R.T.: With Respect To
Results are of bulk production of COMPACT & NORMAL yarn.



long/extra long cotton is used; same roving is used with respect to each count, on both systems. And highlight the superiority of compact yarn.

Material and Method

These studies were carried out on regular production in different mills by using their regular mixing, on conventional and compact yarn. Same roving is used and testing is done in their own laboratories. Block crelling and cross caning technique is used from card to simplex.

It can be observed that Compact Combed cotton yarns reported 3 percent less Irregularity, 30 percent less IPI, 7 percent higher RKM, 10 percent less UT-4 Hairiness and 70 percent less S3 Hairiness over the Conventional Combed ring spun yarn. Similarly compact carded cotton yarn for the same count range resulted in 5 percent less Irregularity, 35 percent less IPI, 10 percent higher RKM, 15 percent less UT-4 hairiness and 80 percent less S3 hairiness, over the conventional carded ring spun yarn.

Other than Yarn Irregularity, IPI, RKM & Hairiness, Others yarn parameters such as Strength, Elongation, Short IPI, Clasimate Faults, Production etc; of compact yarn are also better than ring spun yarn and these results are advantages in the down stream processing.

Knitting

Due to low hairiness and low pilling tendency compact yarn ensures good wear behavior and result in better running properties and improved quality. Since fiber fly and oil can not combine to form clumps of fly, which are occasionally knitted into the fabric and can cause thread & needle breaks, the wear on guide elements, needles and sinkers is reduced as a result of lower residual dust content of compact yarn. Due to low twist, body twist is also minimize.

Sizing

Clinging tendency of compact yarn displays considerably less pronounced clinging phenomena. Due to lower clinging tendency of yarn results in improvement of reparability of the warp. This reduces the cost of sizing and subsequently de-sizing, at the same time, resulting in lesser environment pollution.

Weaving

Despite the lower degree of sizing, thread break rates are lower, which significantly improves efficiency.

Finishing

The higher stretch recovery is also retained in the finished fabric. This is an advantage, especially in shirting fabrics with non-iron finish. Printed fabrics appearance looks better due to less hairiness.

Twisting

The advantage in spinning also has an impact, when it comes to twisting. In compact yarn less twist is possible, without any loss of strength. This results in lower manufacturing cost and the opportunity to manufacture new & softer twist yarns.

Singeing

The customary addition of weight to the yarn count, which is burned off in singeing is no longer necessary. This amounts to raw material saving. The re-winding process, which is usually necessary to remove the singeing dust for the ply/ single yarn can also dispensed with.

Advantages of compact yarn:

Other than yarn hairiness, other yarn parameters such as Strength, Elongation, IPI and Uniformity are also better than Ring spun yarn and these advantages can also exploited in down stream processing.

Commercialization

The Compact Spinning System to be commercialized is by Rieter and is called com 4 Spinning. Suessen system was first introduced to the market at ITMA 99 in Paris. This covers full spectrum of raw materials and counts. However compact spinning system is also made by: Zinser, Toyota, Rotorcraft etc; which are designed to accommodate the full spectrum of staple length spin today. These compact spinning systems offer the possibility of using cotton with short staple lengths to long, to produce high quality yarns that heretofore required long or extra long staple cottons.

Com 4 Operating principle

The air current created by the vacuum generated in the perforated drum condenses the fibers after the main draft. The fibers are fully controlled all the way form the nipping line after the drafting zone to the spinning triangle.

An additional nip roller prevents the twist form being propagated into the condensing zone. The compacting efficiency in the condensing zone is enhanced by a specially designed and patented air guide element. Optimal interactions of the compacting elements ensure complete condensation of all fibers. Compact zone, consists of:

- Perforated drum
- suction insert and
- air guide element.

The directly driven perforated drum is hard to wear and resistance to fiber clinging. Inside each drum there is an exchangeable stationary suction insert with a specially shaped slot. It is connected to a machined suction system.

Suessen EliTe System

After the introduction in ITMA, 99 in Paris. It achieved in a short span of time, a reputation as being the most versatile and user friendly system. After the fiber leaves the drafting system, they are condensed by air permeable lactic apron. This slides over an inclined suction slot.

The fibers follow this suction slot and at the same time they perform a lateral rolling motion, twist is being inserted. There is no spinning triangle. It is of technological importance that the suction level relevant for the condensing operation is exactly the same for all spinning positions. To fulfill these criteria suction pumps are installed driven by a motor. Each suction pump covers 24/30 spinning positions. This provides short air-flow distances with identical negative pressure on all spinning positions. Suessen EliTe has maximum market share and user friendly. Other than Elite Compact yarn Suessen has EliTwist (Compact) and EliCore (Compact). Which are verities.

RocoS

Compact yarn is produced by compacting the strain of fiber in a condensing zone, arranged after the drafting system, as not to allow the formation of spinning triangle while twisting the strands of fiber into yarn. Rocos the Rotorcraft compact spinning system avoid s these and works without air suction using magnetic mechanical principal. It is suitable for cotton, its blends with synthetic fibers as well as pure synthetics from coarse to fine counts. It consists of: 1-Bottom roller 2-Front Roller 3-Delivery Roller 4-With supra magnetic equipped ceramic compactor, 5-Supporting bridge and 6-Roving guides. In this system no air suction, no air pipes, no perforated drum or aprons and no extra power is required. Any ring spinning machine can be converted with this within hours, with out any extra ordinary skill requirements.

Toyota

When the fibers leave the drafting zone they are compacted by condense apron, whereas condense system is driven by front bottom roller with Toyota's specially designed driving system.(Positive drive) Individual motors combined with suction units for spinning position have been arranged accordingly this provides short air flow distances with identical negative pressure application of air suction to condense the fibers stream results in virtual elimination of the spinning triangle resulting in improved yarn characteristics.

Zinser

Using the compact spinning technology is possible not only in the field of combed cotton yarn but is also reasonable and profitable in other fields. Precondition for this is a compact spinning technology that is flexible and can be adapted to different applications. This compact spinning technology is based on a perforated apron. All raw materials can be processed to all major yarn counts.

Compact Solution

The compact solution shows the advantages involved in using such a flexible system, this however not only applies to the field of combed cotton ring yarn but also to carded ring yarn blends of cotton with manmade fibers (carded and combed). Pure manmade fibers the highlights at a glance are.

- ❖ The whole world of application of conventional ring spinning also for compact spinning.
- ❖ All important raw materials can be processed to produce all major yarn counts.

Not only combed cotton ring yarn but also carded ring yarns, blends of cotton with manmade fibers (carded and combed) pure manmade fibers. Other compacting systems are Marzoli, Wuxi No7, Hua Fang (Jiangyin Huafang New Technology & Scientific Research Co; Ltd), Jiang dong, Fanji, Rifa, Shanghai Erfanji, song Bao, Dechang, and Jingwei etc. Some Chinese Compact manufacturer used duct (like pneumaphil duct) with separate box for compacting instead of suction fans.

The evolution of Compact Spinning technology has generally altered the relationship between fiber properties and yarn quality, different processed will likely involve different fiber interactions. This alters the optimum combinations of fiber properties, the possibility of using cotton with short staple length to produce high quality yarn that here-to-fore required longer or extra Lang cottons, are the possibility to use in compact spinning.

In Compact Spinning there are still doors to open, like carded compact yarn nearly equivalent to conventional combed ring yarn. Blended yarn etc; all the possibilities are Opening a wide field for the creation and development of future products and applications. Reduced yarn hairiness and improved tensile properties are the key benefit of the compact yarn. Both characteristics are crucial for yarn performance in downstream manufacturing processes. Compact spinning technology has potential for improving both the quality and profitability.

These can be done by:

- ❖ Reducing the cost of raw material while maintaining yarn quality;
- ❖ Reducing twist while using the same raw material; and/or
- ❖ Eliminating some or all the combing and still producing acceptable yarn quality.

The advantageous compact yarns can be economically utilized in a variety of ways. All these possibilities are opening wide field for the creation and development of future products and applications, singing can be completely or partially dispensed with. It cane can be said about sizing, which can be saved. If the strength of the conventional yarn is sufficient for the intended applications, using the compact technology will allow a reduction of twist. This means, increased production and reduced consumption.

Print in printing more brilliant due to better dye uptake piling resistance luster and strength increase. And last but not the least. Whenever the properties of conventional ring yarn and fully sufficient for the desired use compact yarn can be spun form less expensive raw material or conventional combed yarn can be replaced by compact carded yarn.

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