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COMPARATIVE STUDY ON COTTON YARN QUALITY MADE FROM COMPACT AND CONVENTIONAL RING FRAME

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ABSTRACT

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Compact or condensed spinning technology is widely considered as the new benchmark for staple yarn quality. This study presents an analysis and comparison of the properties of cotton yarn made from EliTe compact from Suessen (Germany) and conventional ring frames. Conventional ring (combed) and compact cotton yarns with different linear densities of 40/1Ne, 30/1 Ne, 20/1Ne were produced from the same middle staple cotton (CIS Uzbekistan) on both spinning frames. The yarn quality parameters such as tensile, elongation, mass irregularity, yarn faults and hairiness of both types of yarn were tested and compared. It was observed that yarn spun from EliTe compact spinning frame have following advantages when compared to those spun on the conventional ring frame: higher tenacity and elongation at break, lower mass irregularity measured on short segments, and a significant smaller number of faults such as thin & thick places as well as higher degree of elasticity and a considerable lower hairiness.

Key words: *compact yarn, cotton fibre properties, compact spinning, yarn hairiness, elongation, IPI, CSP value of yarn*

INTRODUCTION

In spite of modernization and rapid technological development in the field of ring spinning, the mechanism ring traveler spindle has remained almost the same until now. Furthermore ring spinning remains the dominant spinning technology even today. The producers of modern spinning frames have been developing the machines with improved construction of different working elements and optimal spinning geometry. All optimization and improvements of the ring spinning frame however have not enabled the reduction of the spinning triangle which can be defined as the most problematic and weakest point in the yarn formation process using the ring traveler system (Hecthi 1996; Egbers 1999). The spinning triangle that occurs while the yarn is formed is the cause of many fibres leaving the drafted roving or being partly spun into the yarn with end only. This causes greater waste of fibres, lower exploitation of fibre tenacity in yarn, poorer appearance and greater hairiness of the spun yarn. Compact spinning offered the potential to create a near perfect yarn structure by applying air suction to condense the fibre stream in the main drafting zone, thereby virtually eliminating the spinning triangle (Artzt 1998 and 1999; Ei Mogahzy 2000; Stalder and Rusch, 2002; Kaifa and Ethridge, 2003; Rust and Peykaian, 1992; Suessen 1999). The purpose of this study presented in this article was to produce, analyze and compare the physical properties of yarn made from conventional ring and Sussen compact system.

Conventional ring versus compact ring spinning system

The twist that is transmitted to the yarn in the ring spinning process originates along the curve between the traveler and front drafting rollers. Transmission of the twists is to opposite to the yarn movement in this area. The traveler transmits twists to already drafted fibres as close as possible to the clamping point after the front rollers. However the twists never reach the clamping point, because after leaving the front rollers the fibres tend to direct towards yarn axis. The different length of the path of the inner and outer fibres that from the yarn cause a so called spinning triangle in ring spinning (Olbrich 2000). Principle of ring spinning and Spinning triangle are shown in Fig. 1 and 2. The length of the spinning triangle depends on spinning geometry and twisting intensity (Kampen 1987). The form and dimensions of the spinning triangle significantly influence the structure, surface characteristics, physical and mechanical characteristics of spun yarn.

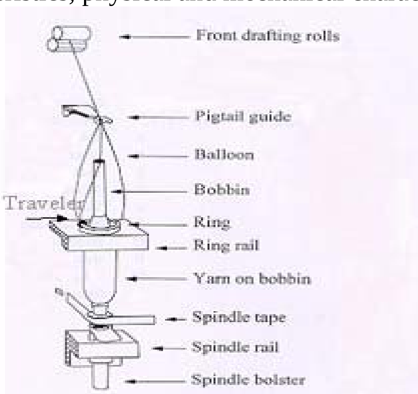

Fig. 1. Principle of Ring Spinning

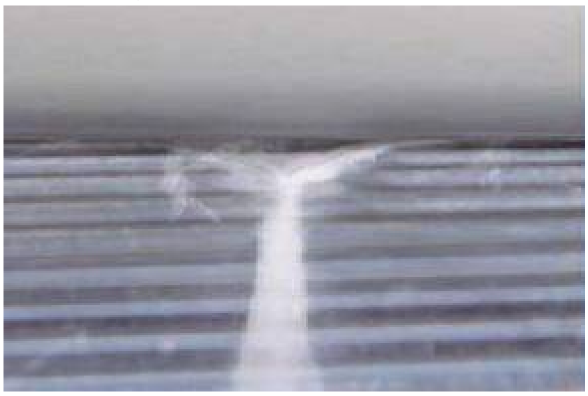

Fig. 2. Spinning triangle of conventional Ring frame

Compact yarns are claimed to be stronger and less hairy due to the improved fibre binding and better yarn elongation, work capacity, yarn irregularity and IPI values compared with conventional ring yarn (Frey 2001; Stalder 2002; Egbers 1999). The difference in yarn strength, elongation and hairiness values in comparison with conventional ring yarn in higher with carded yarns (Stahlecker 2000). The ends down rate in spinning can be reduced by up to 50% wich improves machine efficiency (http:www.suessen.com). A smoother combed like appearance can be achieved with carded cotton due to lesser hair (Egbers 1999). Yarn structure of conventional ring (A) and compact yarn (B) of 100% cotton (Frey 2001) are shown in Fig. 3.

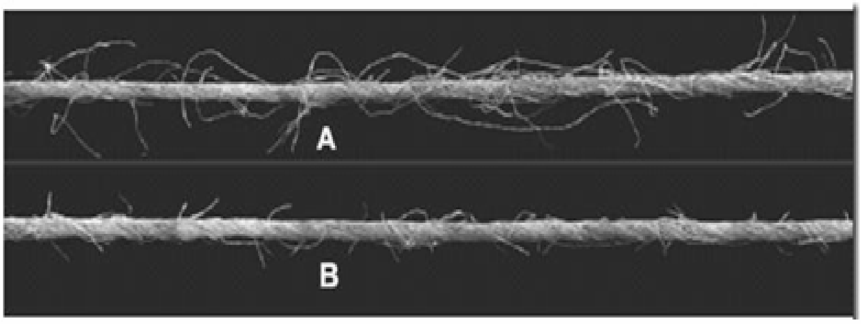

Fig. 3. Yarn structure of conventional ring (A) and compact yarn (B) of 100% cotton (Frey 2001)

Principles of suessen elite spinning system

The system consists of an additional “drafting zone”, which is mounted on a standard 3 roll ring spinning machine (Fig. 4). In this drafting zone an air permeable lattice apron (Fig. 5) runs over a suction tube. The suction tube is under negative pressure and there is a slot tilted in the direction of fibre movement for each spinning position. After the fibres leave the front roller nip line, they are guided by means of the lattice aprons over the openings of suction slots where they move sideways and condensed due to suction air flow. The openings of the suction slots are in an incline to the direction of fibre flow. This helps condensing by generating a transverse force on the fibre band during the transport over the slot and causing the fibre band to rotate around its own axis. The lattice apron carries the fibres attached to it up to the delivery nip lone. The diameter of delivery (driven) top roller is slightly bigger than the diameter of the front top (driving) roller. This generates a tension in the longitudinal direction during the condensing process. The tension ensures the straightening of curved fibres, and therefore supports the condensing effect of the negative pressure acting on the fibre band in the slot area of the suction tube (Stahlecker 2000; Frey 2001).

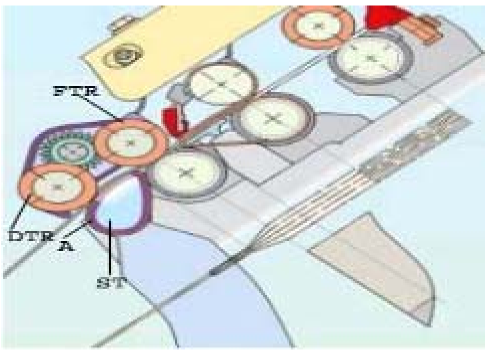

Fig. 4. Drafting equipment of the Suessen EliTe Compact system unit(ST-suction tube, A-lattice apron, FTR-front top roller, DTR-delivery top roller) (Frey 2001)

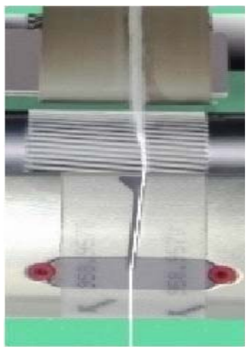

Fig. 5. Suessen Lattice apron (Frey 2001)

MATERIALS AND METHODS

Cotton yarns combed were manufactured on both the compact (EliTe, Suessen, Germany) and conventional ring spinning frames (Toyota –Rx240). The counts of the yarn obtained were 40/1Ne, 30/1Ne and 20/1Ne using CIS Uzbekistan cotton. The yarn was produced from the same lots of roving having been prepared in identical condition in Square Textile Mills Ltd, Bangladesh. High volume instrument (HVI) spectrum was used for testing of fibre micronaire, color, length and strength and Advanced Fibre information System (AFIS) was used to evaluate immature fibre content (IFC) and maturity ratio. Fibre properties from Uster HVI spectrum and AFIS are given in Table 1.

After proper conditioning (relative humidity 65%, temperature 21^{o}C), all yarn samples were tested on the following instruments.

1. Uster tester5(UT-5) for evenness and hairiness and IPI(Imperfection index)
2. Uster Tensojet for Tensile and elongation properties,
3. Uster Auto sorter for measuring count
4. Lea strength tester for CSP value
5. Twist tester for TPI

Quality parameter of Conventional ring and Compact yarn made from 100% cotton fibres produced on Conventional ring (Toyota –Rx240) and Suessen Elite compact system are given in Table 2.

Experimental data

Table 1. Main Fibre properties from USTER HVI Spectrum and AFIS

Cotton Origin	Avg. Mic	Length (mm)	SCI(Spinning Consistency Unit)	GPT	Unf	SFI	Elong	Rd	+b	IFC	Maturity Ratio
CIS Uzbekistan	4.5	29.28	137	30.9	82.9	7.6	5.2	78.8	10.0	4.5	0.94

Table 2. Quality parameter of Conventional ring and Compact yarn made from 100% cotton fibres produced on Conventional ring (Toyota –Rx240) and Suessen Elite compact system

Test parameter	40/1 Ne		30/1 Ne		20/1 Ne	
	Ring Yarn (Combed)	Compact	Ring Yarn (Combed)	Compact	Ring Yarn (Combed)	Compact
Yarn count	39.89	39.7	29.95	29.92	19.83	19.8
Count CV%	0.35	0.6	0.61	0.55	0.93	0.65
Uster (Unevenness) U%	9.76	9.02	8.97	8.73	7.5	7.13
Uster CVm%	12.33	11.4	11.32	11.01	9.76	9
Thin places/km(-50%)	1	0	0	0	0	0
Thick places/km(+50%)	24	14	12	5	4	2
Neps/km(+200%)	35	37	20	21	8	3
IPI	60	51	32	26	12	5
CSP	2549	2789	2411	2473	2722	2862
RKM(CN/Tex)	17.01	19.93	18.29	19.29	19.82	20.07
RKM CV%	11.56	9.08	7.13	9.75	5.91	9.24
Elongation%	4.6	4.81	4.21	4.62	5.03	4.86
Elongation CV%	8.66	8.63	8.06	11.2	5.92	10.62
TPI	23.74	23.19	20.28	19.46	16.59	16.38
Hairiness (H-index)	4.47	3.12	4.79	3.33	5.59	3.98
Hairiness (CVHb)%	3	3	2.2	3.3	3.4	2.3

RESULTS AND DISCUSSION

Yarn Hairiness

Hairiness is the ratio of the total length of protruding fibres (in cm) per cm of yarn. Table 2 contains the averages values and ranges of the main yarn properties made from conventional ring and compact system. The yarn hairiness is characterized by H index by the UT-5. The higher the H value hairier the yarn. Hairiness properties can affect yarn performance, fabric appearance and fabric hand. In Fig. 6 shows that the Uster hairiness (H) of compact yarns is significantly lower when compared with the hairiness with conventional ring yarn. In 40/1 Ne cotton yarn (conventional ring) H index was 4.47 and Compact system Hairiness index was reduced to 3.12. Same as 30/1 conventional H index was (4.79), in Compact system it was reduced to 3.33.In 20/1Ne (conventional) it was

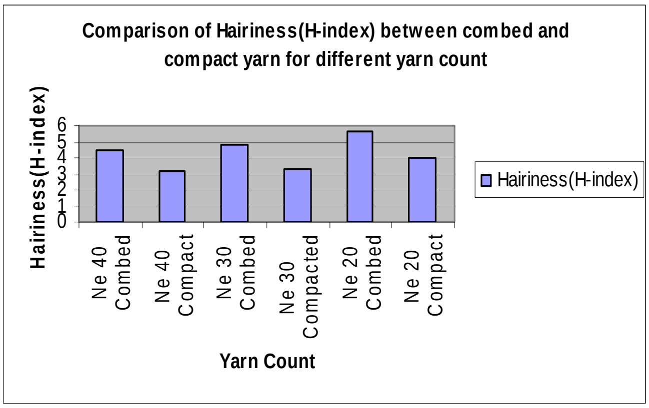

Fig. 6. Hairiness (H-index) of conventional ring and compact yarn for different count

5.59 and in compact it was reduced to 3.98. The reason for this the construction of the drafting equipment of compact system and in this system all the fibre will remain parallel in condensed position. In conventional ring system not all fibres that are placed at the external edges of the triangle can be spun into the yarn structure, and can leave the drafting equipment without having been spun into the yarn. Such fibres also increase yarn hairiness (http:www.suessen.com).

Yarn Imperfection Index (IPI)

In Fig. 7 it was shown that IPI of all yarn produced from compact system was lower than the conventional yarns. In 40/1 Ne(Compact) yarn IPI was reduced to 15%, 30/1 reduced to 18.75% and 20/1 Ne it was reduced to 58.33% in compared with conventional ring yarn. IPI was reduced due to fewer amounts thin & thick places and neps present in compact yarn.

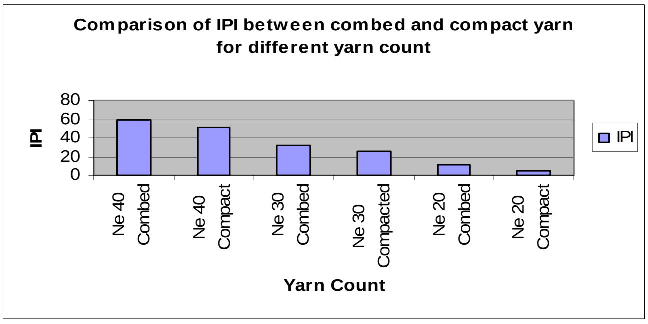

Fig. 7. IPI of conventional ring and compact yarn for different count

Count Strength product (CSP)

In Fig. 8 it was clearly showed that CSP values of Compact yarn are higher than conventional yarn due to all the fibres contribute in yarn formation during spinning in compact system. The uniform pre tension of the majority of fibres enables more synchronic breakage of the majority of the fibres, which contributes to higher yarn strength and better utilization of fibre tenacity. For 40/1 Ne CSP values were higher 9.41% compared to conventional ring. Same in 30/1 Ne 2.57% and 20/1 Ne 5.1% respectively in compared to ring yarn.

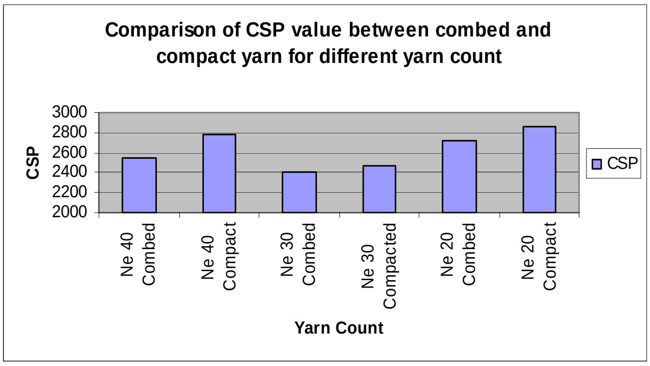

Fig. 8. CSP values of conventional ring and compact yarn for different count

Resistance per kilometer (RKM) of Yarn

In Fig. 9 showed that RKM (CN/Tex) values of all yarn produced from Suessen compact system higher than the conventional ring yarn and improvement percentages was found in compact yarn 17.16%, 5.46%, 1.26% respectively for 40/1 Ne, 30/1Ne and 20/1 Ne.

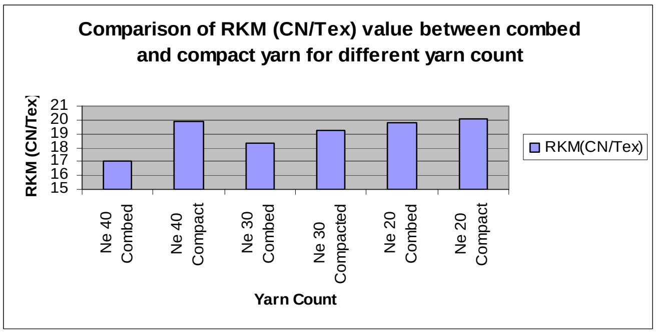

Fig. 9. RKM values of conventional ring l and compact yarn for different count

Elongation Percentage

In Fig. 10 it was clearly shown that the elongation of the Elite type Compact yarn has significantly higher value than that of the conventional ring yarn. Except 20/1 Ne elongation percentages for 40/1 Ne, 30/1 Ne respectively increased 4.61 to 4.81, 4.21 to 4.62.

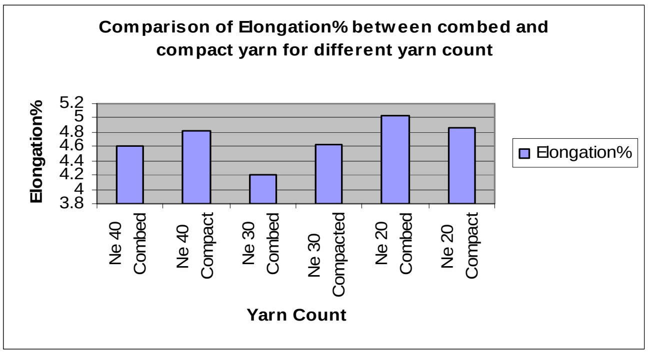

Fig. 10. Elongation % of conventional ring and compact yarn for different count

Uster unevenness (U %)

Irregularity (Unevenness) of mass number indicates the amount of overall mass variation in percentages from the mean mass of the tested sample. In Fig. 11 it was clearly shown the all Compact yarn made from Suessen EliTe system have lower U% than the conventional ring yarn due to less hairiness on the yarn surface. In 40/1Ne (conventional) ring yarn Uster U% was 9.76 and in compact system it reduced to 9.02. Same as in 30/1 Ne(conventional)l ring U% was 8.97, in compact it was reduced to8.73, 20/1 Ne in conventional U% was7.5; in compact it was reduced to 7.13. So in compact system more even yarn can be produced.

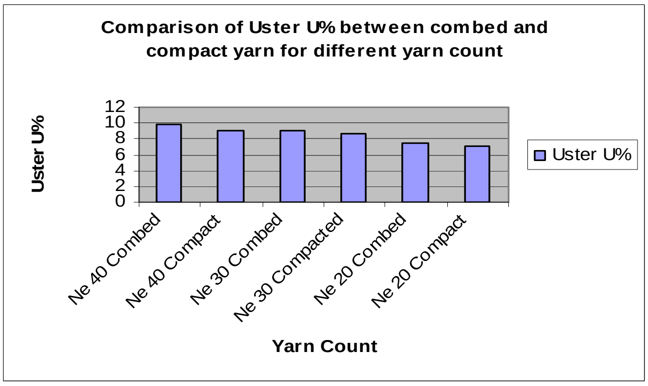

Fig. 11. Uster U% of conventional ring and compact yarn for different count

CONCLUSION

The aim of the study presented here was to compare the quality of cotton yarns made from Suessen compact and conventional ring frame led to the following conclusion: Compact yarns can be regarded as completely new ring spun yarn types as regards their morphological, physical and mechanical properties. The compact yarns have the following advantages when compared to the conventional ring yarns: significantly reduced hairiness, smooth surface, high gloss, improved tenacity, elongation percentages and IPI values etc. If the spinning mills customers ,producers of woven and knitted fabrics require the high quality spun yarns and are ready to pay approximately a 10% higher price for them (because higher cost of compact system and slightly higher energy costs) then compact spinning has promising future because of higher production and improved quality of compact yarns

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